KARNATAK UNIVERSITY, DHARWAD
ACADEMIC (S&T) SECTION

ಕರ್ನಾಟಕ ವಿಶ್ವವಿದ್ಯಾಲಯ, ಧಾರವಾಡ
ವಿದ್ಯಾಮಂಡಳ (ಎಸ್&ಟಿ) ವಿಭಾಗ

ಸ್ವಾತಂತ್ರ್ಯದ ಅಮೃತ ಮಹೋತ್ಸವ

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NAAC Accredited
'A' Grade 2014

website: kud.ac.in

No. KU/Aca(S&T)/JS/MGJ(Gen)/2024-25/436 Date: 11 NOV 2024

ಅಧಿಸೂಚನೆ

ವಿಷಯ: ರಾಷ್ಟ್ರೀಯ ಶಿಕ್ಷಣ ನೀತಿಯನುಸಾರ 2024–25ನೇ ಶೈಕ್ಷಣಿಕ ಸಾಲಿನಿಂದ ಎಲ್ಲ ಸ್ನಾತಕೋತ್ತರ ಪದವಿಗಳಿಗೆ / ಸ್ನಾತಕೋತ್ತರ ಡಿಪ್ಲೋಮಾಗಳಿಗೆ ಪಠ್ಯಕ್ರಮವನ್ನು ಪ್ರಕಟಣೆ ಕುರಿತು.

ಉಲ್ಲೇಖ: 1. ವಿದ್ಯಾವಿಷಯಕ ಪರಿಷತ್ ಸಭೆಯ ನಿರ್ಣಯ ಸಂಖ್ಯೆ: 2 ರಿಂದ 9, ದಿ: 08.11.2024.

2. ಮಾನ್ಯ ಕುಲಪತಿಗಳ ಅನುಮೋದನೆ ದಿನಾಂಕ: 11.11.2024.

ರಾಷ್ಟ್ರೀಯ ಶಿಕ್ಷಣ ನೀತಿಯನುಸಾರ 2024–25ನೇ ಶೈಕ್ಷಣಿಕ ಸಾಲಿನಿಂದ ಅನ್ವಯವಾಗುವಂತೆ, ಕರ್ನಾಟಕ ವಿಶ್ವವಿದ್ಯಾಲಯದ ಎಲ್ಲ ಸ್ನಾತಕೋತ್ತರ ಪದವಿಗಳಾದ M.A./ M.Sc / M.Com / MBA / M.Ed 1 ರಿಂದ 4ನೇ ಸೆಮೆಸ್ಟರ್‌ಗಳಿಗೆ ಮತ್ತು 1 & 2ನೇ ಸೆಮೆಸ್ಟರ್‌ಗಳ ಸ್ನಾತಕೋತ್ತರ ಡಿಪ್ಲೋಮಾಗಳಿಗೆ ವಿದ್ಯಾವಿಷಯಕ ಪರಿಷತ್ ಸಭೆಯ ಅನುಮೋದನೆಯೊಂದಿಗೆ ಈ ಕೆಳಗಿನಂತೆ ಪಠ್ಯಕ್ರಮಗಳನ್ನು ಅಳವಡಿಸಿಕೊಳ್ಳಲಾಗಿದೆ. ಕಾರಣ, ಸಂಬಂಧಪಟ್ಟ ಎಲ್ಲ ಸ್ನಾತಕೋತ್ತರ ವಿಭಾಗಗಳ ಅಧ್ಯಕ್ಷರು / ಸಂಯೋಜಕರು / ಆಡಳಿತಾಧಿಕಾರಿಗಳು / ಮಹಾವಿದ್ಯಾಲಯಗಳ ಪ್ರಾಚಾರ್ಯರುಗಳು / ಶಿಕ್ಷಕರು ಸದರಿ ಪಠ್ಯಕ್ರಮಗಳನ್ನು ಅನುಸರಿಸುವುದು ಮತ್ತು ಸದರಿ ಪಠ್ಯಕ್ರಮವನ್ನು ಕ.ವಿ.ವಿ. ಅಂತರ್ಜಾಲ www.kud.ac.in ದಲ್ಲಿ ಬಿತ್ತರಿಸಲಾಗಿದನ್ನು ಸಂಬಂಧಪಟ್ಟ ವಿದ್ಯಾರ್ಥಿಗಳಿಗೆ ಸೂಚಿಸುವುದು.

Arts Faculty

Sl.No	Programmes	Sl.No	Programmes
1	Kannada	8	MVA in Applied Art
2	English	9	French
3	Folklore	10	Urdu
4	Linguistics	11	Persian
5	Hindi	12	Sanskrit
6	Marathi	13	MPA Music
7	MVA in Painting		

Faculty of Science & Technology

Sl.No	Programmes	Sl.No	Programmes
1	Geography	10	M.Sc (CS)
2	Chemistry	11	MCA
3	Statistics	12	Marine Biology
4	Applied Geology	13	Criminology & Forensic Science
5	Biochemistry	14	Mathematics
6	Biotechnology	15	Psychology
7	Microbiology	16	Applied Genetics
8	Zoology	17	Physics
9	Botany	18	Anthropology

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Faculty of Social Science

Sl.No	Programmes	Sl.No	Programmes
1	Political Science	8	Journalism m & Mass Commn.
2	Public Administration	9	M.Lib. Information Science
3	History & Archaeology	10	Philosophy
4	A.I.History & Epigraphy	11	Yoga Studies
5	Economics	12	MTTM
6	Sociology	13	Women's Studies
7	MSW		

Management Faculty

Sl.No	Programmes	Sl.No	Programmes
1	MBA	2	MBA (Evening)

Faculty of Commerce

Sl.No	Programmes	Sl.No	Programmes
1	M.Com	2	M.Com (CS)

Faculty of Education

Sl.No	Programmes	Sl.No	Programmes
1	M.Ed	2	M.P.Ed

OEC subject for PG

Sl.No	Programmes	Sl.No	Programmes
1	Russian	5	Veman Peetha
2	Kanaka Studies	6	Ambedkar Studies
3	Jainology	7	Chatrapati Shahu Maharaj Studies
4	Babu Jagajivan Ram	8	Vivekanand Studies

PG Diploma

Sl.No	Programmes	Sl.No	Programmes
1	PG Diploma in Chatrapati Shahu Maharaj Studies	2	P.G. Diploma in Women's Studies
3	P.G. Diploma in Entrepreneurial Finance		

ಕುಲಸಚಿವರು.

ಅಡಕ: ಮೇಲಿನಂತೆ

ಗೆ,

1. ಕ.ವಿ.ವಿ. ಸ್ನಾತಕೋತ್ತರ ಅಧ್ಯಕ್ಷರುಗಳಿಗೆ / ಸಂಯೋಜಕರುಗಳಿಗೆ / ಆಡಳಿತಾಧಿಕಾರಿಗಳಿಗೆ / ಮಹಾವಿದ್ಯಾಲಯಗಳ ಪ್ರಾಚಾರ್ಯರುಗಳಿಗೆ
2. ಎಲ್ಲ ನಿಖಾಯದ ಡೀನರು, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.

ಪ್ರತಿ:

1. ಕುಲಪತಿಗಳ ಆಪ್ತ ಕಾರ್ಯದರ್ಶಿಗಳು, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
2. ಕುಲಸಚಿವರ ಆಪ್ತ ಕಾರ್ಯದರ್ಶಿಗಳು, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
3. ಕುಲಸಚಿವರು (ಮೌಲ್ಯಮಾಪನ) ಆಪ್ತ ಕಾರ್ಯದರ್ಶಿಗಳು, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
4. ಅಧೀಕ್ಷಕರು, ಪ್ರಶ್ನೆ ಪತ್ರಿಕೆ / ಗೌಪ್ಯ / ಜಿ.ಎ.ಡಿ. / ವಿದ್ಯಾಂಡಳ (ಪಿ.ಜಿ.ಪಿಎಚ್.ಡಿ) ವಿಭಾಗ/ ಸಿಸ್ಟಮ್ ಅನಾಲೆಸಿಸ್ಟ್ / ಸಂಬಂಧಿಸಿದ ಪದವಿಗಳ ವಿಭಾಗಗಳು, ಪರೀಕ್ಷಾ ವಿಭಾಗ, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
5. ನಿರ್ದೇಶಕರು, ಕಾಲೇಜು ಅಭಿವೃದ್ಧಿ / ವಿದ್ಯಾರ್ಥಿ ಕಲ್ಯಾಣ ವಿಭಾಗ, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
6. ನಿರ್ದೇಶಕರು, ಐ.ಟಿ. ವಿಭಾಗ, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ ಇವರಿಗೆ ಕ.ವಿ.ವಿ. ಅಂತರ್ಜಾಲದಲ್ಲಿ ಪ್ರಕಟಿಸುವುದು.

KARNATAK UNIVERSITY, DHARWAD

Faculty of Science and Technology

Two Years PG Programme

M. Sc., Course in Physics

Programme Structure and Syllabus

As per NEP-2020

With Effect from 2024-25

Karnatak University Dharwad

Department of Physics

Preamble:

The Department of Physics, one of the oldest and major Departments at Karnatak University, was founded in the year **1953**. Eminent spectroscopist Dr. N.R.Tawade was the first Head of the Department and its faculty included very distinguished Scientists. At present the Department has 6 teaching faculty, 7 teaching assistants, 34 research scholars and 166 M.Sc. Students. The Department has had a tradition of strong teaching program and quality research output. As a result, it has been nationally recognized for excellence in teaching and research programs with major grants from UGC under Special Assistance Program (SAP) and DST under FIST program and for the individual faculty members from UGC, DST, BRNS and IUAC. Under the UGC-SAP Program, the Department is recognized as Centre of Advanced Study at Level-II with a grant of Rs 2.63 Cr and the Department is associated with UGC`s the Center with Potential for Excellence in a Particular Area(CPEPA) involving other Science Departments, KUD, as well. While most of the passed-out students have become College teachers and allied job holders, a small but significant number of the students have excelled as Scientists (some are Bhatnagar awardees), University faculty and Vice-Chancellors, and likewise some are successful in foreign countries. Department celebrated diamond jubilee year during the 2013-14. It has produced more than 198 Ph.Ds. so far and published more than 1600 research papers in peer-reviewed National and International journals.

The Course Details:

The Department offers M.Sc. and Ph.D. Program in the Physics. The M.Sc. Program is of two-year course, spread over four semesters, each of which is sixteen weeks duration. The Course comprises Compulsory and Specialization Courses and Open Elective Courses (OECs). A student admitted to the course leading to a M.Sc. degree should necessarily study the compulsory and specialization courses in Physics, offered in the Department as well as the Open Elective Courses in different subject(s), offered by other Departments of KUD. The student has the freedom to choose two courses during the study under prescribed OECs.

There are 6 compulsory and 8 specialization theory courses, 7 practical courses and one project. Out of these, 10 theory courses and 4 practical courses are common to all the students studying in I and II Semesters. The remaining 4 theory courses, 3 practical courses and a project work are specialization-based courses offered in the III and IV semesters. Specialization courses are offered in the following subjects:

(1) Atomic & Molecular Physics

(2) Condensed Matter Physics

(3) Electronics & Communications

(4) Nuclear & Particle Physics

Intake: Total intake to the M.Sc. course in Physics under the jurisdiction of Karnatak University is **275**. The intake for the course at the Department of Physics, Karnatak University, Dharwad, is **83**. The course is also offered at Karnatak Science College with intake of **40**, JSS College, Dharwad with intake of **60** (**30** under KUD quota + **30** under Management quota), Sri Siddeshwar First Grade Govt College, Naragund, with intake of **15** under KUD quota, JT Science College, Gadag, with intake of **30** (**15** under KUD quota + **15** under Management quota) and KSS College, Gadag, with intake of **50** (**25** under KUD quota + **25** under Management quota). The Karnatak University reserves the right to vary intake as deemed necessary including admission rules, fee structures and roster as per notification from time-to-time.

Co-Curricular and Extra Curricular Activities:

Co-Curricular Activities: Seminars, tutorials, mentoring programmes, problem solving sessions and discussion classes are periodically conducted. However, these activities do not carry any marks or credits.

Computer Laboratory Facilities: Students are provided with computer facilities for their curricular as well as for their co-curricular studies and internet browsing in the Department.

Library Facilities: The Department has a library with research journals and text/reference books. Students are allowed to borrow the books on regular basis.

Students Counseling: Students will be assigned to teachers for counseling regarding their academic and other matters.

Epsilon Club: Students council called ‘ε’ (epsilon) club exist in the Department for the all-round development of the students. Lectures by students, staff and special lectures by eminent Scientists are arranged under the auspices of this club.
Extra-Curricular activities such as sports, literary and cultural activities are also conducted under the auspices of this club.

Special Encouragement: Students interested in research activities are encouraged by providing them with an opportunity to work in the research laboratories and USIC under the guidance of the faculty members.

GENERAL INSTRUCTIONS

I. CREDIT, WORKLOAD AND SYLLABUS EQUIVALENCE:

1. One credit is equal to 1 hour theory teaching per week.
2. One credit is equal to 2 hour practical teaching per week.
3. One credit is equal to 15 hours theory syllabus per semester (1 Unit is equal to 15 Hours)
4. One credit is equal to 30 hours practical syllabus per semester (1 credit practical is equal to 2 hours/ week).

A. Workload for Theory Subjects:

1. There shall be 16 hrs/week workload for Assistant Professor.
2. There shall be 14 hrs/week workload for Associate Professor/ Professor/Senior Professor.
3. There shall be 2hrs/week workload relaxation for Guiding Ph.D. students.

B. Workload for Practical Subjects:

1. There shall be 20 hrs/week workload for Assistant Professor.
2. There shall be 18 hrs/week workload for Associate Professor/ Professor/Senior Professor.
3. There shall be 2hrs/week workload relaxation for Guiding Ph.D. students.

C. Workload for Practical Batches:

1. A batch of 10-12 students shall have 1 teacher.

D. Workload for Project:

1. Students for projects / internship shall be preferably guided by permanent faculty for at least 10 students by sharing equally among the permanent faculty. If remained excess shall be allotted to other teacher's on roll on temporary basis.
2. If there is no permanent faculty, the students shall be distributed among the temporary teachers on roll.
3. There shall be maximum of 4 hrs/week workload for guiding the students for project work irrespective of number of students.

II. ALLOTMENT OF SPECIALIZATION:

While allotting specialization in 3rd and 4th semester, minimum of 10 students shall have to select the specialization.

III. **ATTENDANCE:** 75% attendance is mandatory for every course (paper). No marks are reserved for attendance. If the candidates fail to fulfill 75% attendance in any one of the course (paper) in the given semester, such candidate is not eligible to appear for examination in all the papers and candidate has to get the readmission for such semester. However, up to 20% attendance may be condoned with the supportive documents for a student who represents University /State / National level sports, cultural and other events. Monthly attendance shall be displayed on notice board.

IV. CREDIT AND MARKS EQUIVALENCE:

1. Generally, 20% weightage for Formative assessment and 80% weightage for Summative assessment.

2. Up to 2 credits equal to 50 marks (10 marks Formative assessment and 40 marks summative assessment).
3. 3-4 credits equal to 100 marks (20 marks Formative assessment and 80 marks summative assessment).
4. 5-6 credits equal to 150 marks (30 marks Formative assessment and 120 marks summative assessment).
5. Example for 100 marks out of which 20 marks for Formative assessment i.e., Formative Assessment shall be in two internal assessments i.e.: 10 marks I.A. for 8th week and 10 marks for 14thweek of every semester.

V. **Conduct of Examination:**

1. Formative assessment examination shall be conducted for 1hr. There shall not be any provision for improvement. A special Formative assessment examination shall be conducted for a student who represents University /State / National level sports, cultural and other events if a schedule is overlapping.
2. 80 marks summative theory examination shall be conducted for 3 hrs and 40 marks for 1.5 hrs.
3. 80/ 40 marks Formative / Summative Practical examination shall be conducted for 4 hrs.
4. There shall be a single examiner for both even and odd semesters' Formative Practical examination.
5. There shall be a single examiner for odd semester Summative Practical examination and two examiners for even semester Summative Practical examination; one from internal and other shall be external examiner.

VI. **Assessment:**

1. **Theory Papers:** There shall be a single valuation for odd semester theory papers preferably internal examiner and double valuation for even semesters; one from internal and other shall be external examiner.
2. **Project/Internship Assessment**

A) **For100 marks Project/Internship Assessment (Wherever Applicable):**

i. **Formative Assessment**: Project/Internship assessment carrying 20 marks out of 100 marks Candidate has to submit two Progress Reports; each carries 10 Marks. i.e. 10 x 2= 20 marks.

ii. **Summative Assessment**: Project/Internship assessment carrying 80 marks out of 100 marks

a. Project Report : 35
b. Presentation : 25
c. Viva-voce : 20

B) **For150 marks Project/Internship Assessment (Wherever Applicable):**

i. **Formative Assessment**: Project/Internship assessment carrying 30 marks out of 150 marks Candidate has to submit two Progress Reports; each carries 15 Marks. i.e. 15 x 2= 30 marks.

ii. **Summative Assessment:** Project/Internship assessment carrying 120 marks out of 150 marks

a. Project Report : 60

b. Presentation : 35
c. Viva-voce : 25

VII. Passing Criteria:

1. There shall be no minimum passing marks for Formative assessment.
2. Candidate has to score minimum 40% in summative examination and fulfill 40% of the maximum marks including Formative assessment marks. For example: for 80 marks summative examination, candidate has to score minimum of 32 marks (40%) and should score cumulatively 40 marks including formative assessment in every course.

VIII. DECLARATION OF RESULT:

1. Candidate has to score 40% as above in all the courses to pass the semester end examination to declare pass.
2. **Percentage and Grading:** Result shall be declared in terms of SGPA and at the end of four semesters as CGPA. The calculation of CGPA is as under
3. If P is the percentage of marks secured (IA + semester end score) by the candidate in a course which is rounded off to the nearest integer, the grade point (GP) earned by the candidate in that course will be given as below.

Percentage (%)	Grade(GP)	Percentage (%)	Grade(GP)
40	4.0	71-75	7.5
41-45	4.5	76-80	8.0
46-50	5.0	81-85	8.5
51-55	5.5	86-90	9.0
56-60	6.0	91-95	9.5
61-65	6.5	96-100	10.0
66-70	7.0		

Grade point of less than 4 shall be considered as fail in the course, hence, GP=0 and for the absent candidate also GP=0

4. A student's level of competence shall be categorized by grade point (GP), Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA) of the programme.
5. **Semester Grade Point Average (SGPA):** The SGPA is a ratio of sum of the number of Credit Grade Points scored from all the courses (subject) of given semester to the total credits of such semester in which the candidate studied. (Credit Grade Points of each course = Credits x GP).
6. **Cumulative Grade Point Average (CGPA):** It is calculated as below for 4 semester programme.

CGPA=$(Credit_1 \times SGPA_1) + (Credit_2 \times SGPA_2) + (Credit_3 \times SGPA_3) + (Credit_4 \times SGPA_4)$ / Total credits of programme (sum of credits of 4 semesters).

7. After studying and passing, all the credits prescribed for the programme the degree shall be awarded with CGPA score after rounding off to second decimal and class distinguishing as second class, first class, and distinction along with grade letter as under:

CGPA of the Programme (Degree)	Class obtained	Grade Letter
9.5 to 10.00	Outstanding	A^{++}
7.00 to 9.49	Distinction	A^{+}
6.00 to 6.99	First Class	A
5.50 to 5.99	Second class	B^{+}
5.00 to 5.49		B
4.00 to 4.99	Pass	C
Less than 4.0	Fail/ Reappear	D

8. Each semester Grade Card shall have marks and SGPA and final Grade Card shall have semester wise marks obtained in all semesters, CGPA and % of cumulative marks obtained from all semesters.
9. There shall be Revaluation / Challenge valuations provisions as per the prevailing rules and regulations.
10. Marks obtained from the OEC shall not be considered for award of CASH PRIZE / RANK / GOLD MEDAL.

IX. MAXIMUM DURATION FOR COMPLETION OF THE PROGRAMME:

A candidate admitted to any P.G. Programme shall complete it within a period, which is double the duration of the programme from the date of admission.

X. ANY OTHER TERMS AND CONDITIONS:

Apart from the above, the prevailing rules and regulation are valid for any other matters which are not addressed in this regard.

Total No. of Credits: 98 **Total No. of Maximum Marks: 2,450**

Semester	Type of Course	Theory/ Practical	Course Code	Course Title	Instruction Hour/Week	Total Hours/Sem	Duration of Exam	Marks			Credits
								Formative	Summative	Total	
	DSC-01	Theory	**A1PHY001T**	Mathematical Methods in Physical Sciences	04	60	03	20	80	100	04
	DSC-02	Theory	**A1PHY002T**	Classical Mechanics	04	60	03	20	80	100	04
	DSC-03	Theory	**A1PHY003T**	Basic Electronics and Communication	04	60	03	20	80	100	04
	DSC-04	Theory	**A1PHY004T**	Basic Condensed Matter Physics	04	60	03	20	80	100	04
	DSC-05	Practical	**A1PHY005P**	Practical – I: Electronics & Communication and Condensed Matter Physics (General)	08	120	04	20	80	100	04
I	DSC-06	Practical	**A1PHY006P**	Practical – II: Atomic & Molecular Physics and Nuclear & Particle Physics (General)	08	120	04	20	80	100	04
	Total							**120**	**480**	**600**	**24**
	DSC-07	Theory	**A2PHY007T**	Quantum Mechanics – I	04	60	03	20	80	100	04
	DSC-08	Theory	**A2PHY008T**	Basic Atomic, Laser and Molecular Physics	04	60	03	20	80	100	04
	DSC-09	Theory	**A2PHY009T**	Basic Nuclear and Particle Physics	04	60	03	20	80	100	04
	OEC-01	Theory	**A2PHY201T**	Open Elective Course-I: Modern Physics	04	60	03	20	80	100	04
II	DSC-10	Practical	**A2PHY010P**	Practical – III: Electronics & Communication and Condensed Matter Physics (General)	08	120	04	20	80	100	04
	DSC-11	Practical	**A2PHY011P**	Practical – IV: Atomic & Molecular Physics and Nuclear & Particle Physics (General)	08	120	04	20	80	100	04
	Total							**120**	**480**	**600**	**24**
	DSC-12	Theory	**A3PHY012T**	Quantum Mechanics – II	04	60	03	20	80	100	04
		Theory	**A3PHY101AT**	Atomic and Diatomic Molecular Spectra							
		Theory	**A3PHY101BT**	Electron and Ion Transport							
	DSE-01	Theory	**A3PHY101CT**	Transmission Lines, Waveguides and Satellite Communication							
		Theory	**A3PHY101DT**	Nuclear Properties and Elementary Particles	04	60	03	20	80	100	04
		Theory	**A3PHY102AT**	Spectroscopy Instrumental Methods							
		Theory	**A3PHY102BT**	Magnetism and Dielectrics							
III	DSE-02	Theory	**A3PHY102CT**	Electronic Instrumentation, Signals and Systems	04	60	03	20	80	100	04
		Theory	**A3PHY102DT**	Nuclear Detectors, Accelerators and Neutron Physics							
	OEC-02	Theory	**A3PHY202T**	Open Elective Course – II: A) Instrumental Methods ***OR*** B) Physics of Nanomaterials	04	60	03	20	80	100	04
		Practical	**A3PHY103AP**	Atomic and Molecular Physics Practical – I							
		Practical	**A3PHY103BP**	Condensed Matter Physics Practical – I	08	120	04	20	80	100	04
	DSE-03	Practical	**A3PHY103CP**	Electronics and Communication Practical – I							
		Practical	**A3PHY103DP**	Nuclear and Particle Physics							

				Practical – I							
	DSE-04	Practical	**A3PHY104AP**	Atomic and Molecular Physics Practical – II	08	120	04	20	80	100	04
		Practical	**A3PHY104BP**	Condensed Matter Physics Practical – II							
		Practical	**A3PHY104CP**	Electronics and Communication Practical – II							
		Practical	**A3PHY104DP**	Nuclear and Particle Physics Practical – II							
Total								**120**	**480**	**600**	**24**
IV	DSC-13	Theory	**A4PHY013T**	Classical Electrodynamics	04	60	03	20	80	100	04
	DSC-14	Theory	**A4PHY014T**	Statistical and Thermal Physics	04	60	03	20	80	100	04
	DSE-05	Theory	**A4PHY105AT**	Molecular Spectra and Structure of Polyatomic Molecules	04	60	03	20	80	100	04
		Theory	**A4PHY105BT**	Semiconductors and Devices							
		Theory	**A4PHY105CT**	Microprocessor and Microcontrollers							
		Theory	**A4PHY105DT**	Nuclear Models, Nuclear Reactions and Weak Interactions							
	DSE-06	Theory	**A4PHY106AT**	Lasers, Nonlinear Optics and Nonlinear Spectroscopy	04	60	03	20	80	100	04
		Theory	**A4PHY106BT**	Superconductivity and Advanced Materials							
		Theory	**A4PHY106CT**	Analog and Digital Modulation							
		Theory	**A4PHY106DT**	Nuclear Reactors and Nuclear Decays							
	DSE-07	Practical	**A4PHY107AP**	Atomic and Molecular Physics Practical– III	08	120	03	20	80	100	04
		Practical	**A4PHY107BP**	Condensed Matter Physics Practical– III							
		Practical	**A4PHY107CP**	Electronics and Communication Practical – III							
		Practical	**A4PHY107DP**	Nuclear and Particle Physics Practical– III							
	DSC-15	Project	**A4PHY015AP**	Project in Atomic and Molecular Physics	06	180	04	30	120	150	06
		Project	**A4PHY015BP**	Project in Condensed Matter Physics							
		Project	**A4PHY015CP**	Project in Electronics and Communication							
		Project	**A4PHY015DP**	Project in Nuclear and Particle Physics							
	Total							**130**	**520**	**650**	**26**

M.Sc. SEMESTER – I

Discipline Specific Course (DSC)

Course Title: Mathematical Methods in Physical Sciences
Course Code: A1PHY001T

Type of Course	Theory/ Practical	Credits	Instruction Hour per Week	Total No. of Lectures/ Hours/ Semester	Duration of Exam in Hours	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	Theory	04	04	60	03	20	80	100

Learning Objectives:

1. Understand the properties of special functions like, Legendre functions with their integral representations, the concept of Bessel's function, Hermite function, Laguerre functions, with its properties like recurrence relations, orthogonal properties, generating functions etc.
2. Evaluate mathematical expressions to compute quantities that deal with linear systems and eigenvalue problems.
3. To teach the techniques of the tensor calculus which have wide applications for the study of mathematics, mechanics, physics.
4. Apply the Internal Direct Product Theorem in simple cases. decide whether a given group is cyclic, and given a finite cyclic group, find a generator for a subgroup of a given order.
5. To define the structure and components and how to write loops and decision statements of a Python program.

Course Outcomes:

At the end of Mathematical Methods in Physical Sciences course, the students will be able to

1. Interpret the various special mathematical functions to understand the physical consequences.
2. Discuss and interpret the matrices for solving the physical problems.
3. Apply the group theory for knowing the physical properties of the matter.
4. Describe the mathematical techniques for the statistical interpretation of the physical sciences.
5. Develop algorithmic solutions to simple computational problems.
6. Develop and execute simple Python programs.
7. Develop simple Python programs for solving problems.

Unit	Content	Hours
I	**Special Functions:** Beta and gamma functions. Solution of differential equation using power series-Frobenius method. **Legendre Functions:** Legendre polynomials, Rodrigue's formula; generating function and recursion relations; Orthogonality and normalization; associated Legendre function, special harmonics. **Bessel Functions:** Bessel functions of the first kind, recursion relations and orthogonality. **Hermite Functions:** Hermite polynomials, generating function, recursion relations; Orthogonality. **Laguerre functions:** Laguerre and associated Laguerre polynomials, recursion relations; Orthogonality. Applications of special functions to problems in physics.	**15**
II	**Matrices:** Properties of matrices: Real, symmetric, Normal, triangular, Orthogonal, Hermitian, and unitary matrices; eigenvectors and eigen values, diagonalization of matrices, Matrix representation of linear operators, eigenvalues and eigenvectors of operators, simultaneous eigen vectors and commutativity, matrices in classical and quantum mechanics **Tensors:** Types of tensors, contravariant and covariant tensors, symmetric and antisymmetric tensors, Tensor algebra: equality, addition and subtraction, tensor multiplication, outer product; contraction of indices, inner product, quotient theorem, Kronecker delta, metric tensor, Christoffel symbols. Importance of Tensors in physics problems.	**15**
III	**Group Theory:** Groups, subgroups and classes; homomorphism and isomorphism, group representation, reducible and irreducible representation, Schur's Lemmas, orthogonality theorem, character of a representation, character tables, decomposing a reducible representation into irreducible representations, Continuous groups and their representations, lie groups, rotation groups SO (2) and SO (3). Brief introduction of group theory in quantum mechanics.	**15**
IV	**Python Programming**: Python basics: Introduction to the Python, Python platforms, basic syntax, comments, variables names and rules. Data type: Numeric, string, list, tuples, sets, Dictionaries Python operators: Arithmetic, Assignment, Comparison, Python logical operator, bitwise operator, use Python as a calculator. Python Loops: While loop, for loop etc. Conditional statements, functions: inbuilt and user created functions. Python file handling: open, create new file, read existing file in Python. Python modules: Numpy, pandas, scipy. Data visualization through Matplotlib. Practical examples and Applications: Quantum Mechanics: Eigen functions and probability, Schrodinger wave equations and their solutions in Python, Thermodynamics examples, Lithium-ion batteries example, energy loss by radiation and many more practical example	**15**

Text Books:

1. Mathematical Methods for Physicists (4th edition): George Arfken & Hans J. Weber, Academic Press, San Diego (1995).
2. Mathematical Methods in Physical Sciences (2nd edition): Mary L. Boas, John Wiley & Sons, New York (1983).
3. Mathematical Physics: P. K. Chattopadhyay, Wiley Eastern Ltd., New Delhi (1990).
4. Introduction to Mathematical Physics: Charlie Harper, Prentice Hall of India Pvt. Ltd., New Delhi (1995).
5. Matrices and Tensors in Physics (3rd edition): A.W. Joshi, New Age International (P) Ltd. Publishers, New Delhi (2000).
6. Elements of Group Theory for Physicists (3rd Ed): A.W. Joshi, Wiley Eastern Ltd (1982).
7. Kamthane, A. N., & Kamthane, A.A. Programming and Problem Solving with Python, McGraw Hill Education. 2017.
8. Balaguruswamy E., “Introduction to Computing and Problem-Solving using Python”, 2nd Edition, McGraw Hill Education, 2018.
9. Taneja, S., Kumar, N. Python Programming- A modular Approach. Pearson Education India, 2018.
10. Guttag, J. V. Introduction to computation and programming using Python. MIT Press. 2018.

Reference Books:

1. Mathematical Methods for Physics and Engineering: K. F. Riley, M. P. Hobson and S. J. Bence, Cambridge Univ. Press Cambridge (1998).
2. Advanced Mathematics in Physics and Engineering: Arthur Bronwell, Mc Graw Hill Book Company, New York (1953).
3. Group theory and its Applications to Physical Problems: M. Hammermesh, Addison Wesley, Mass (1962).
4. Schaum's Outline Series: Vector Analysis and Introduction to Tensor Analysis: M.R. Speigel, McGraw Hill Company, Singapore (1983).
5. Mathematical Physics A. K. Ghatak, I. C. Gayal& S. J. Chua, Trinity Publications, 2017.
6. Introduction to Python Programming. Gowrishankar S, Veena A. CRC Press, Taylor & Francis Group, 2019
7. Allen B. Downey, ``Think Python: How to Think Like a Computer Scientist’’, 2nd edition, Updated for Python 3, Shroff/O’Reilly Publishers, 2016.
8. Learning To Program with Python. Richard L. Halterman. Copyright © 2011
9. Python for Everybody, Exploring Data Using Python 3. Dr. Charles R. Severance. 2016.

Formative Assessment for Theory	
Assessment Occasion/ Type	Marks
Internal Assessment Test 1	10
Internal Assessment Test 2	10
Total	20
Formative Assessment as per Guidelines	

Discipline Specific Course (DSC)

Course Title: Classical Mechanics
Course Code: A1PHY002T

Type of Course	Theory/ Practical	Credits	Instruction Hour per Week	Total No. of Lectures/ Hours/ Semester	Duration of Exam in Hours	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	Theory	04	04	60	03	20	80	100

Learning Objectives:

1. To teach students advanced classical mechanics as basis for many areas of Physics.
2. To make students realize the usefulness of Lagrangian formulation.
3. To study motion and scattering of particles in central force field.
4. To discuss the motion in non-inertial frame of reference.
5. To teach advanced rigid body dynamics and small oscillations.
6. To teach Hamilton Jacobi theory and its applications.
7. To make students to learn the rocket dynamics and performance of rocket.

Course Outcomes:

After successful completion of the course on Classical Mechanics, the student will be able to

1. Demonstrate a basic and advanced knowledge of Lagrangian and Hamilton's principles and solve related problems.
2. Demonstrate the concept of motion of a particle under central force, concepts of different orbits and apply advanced methods to deal with central force problems.
3. Understand the kinematics and dynamics of rigid body and Euler's equations of motion and gain good knowledge about dynamics of small oscillatory systems.
4. Understand the details of fixed and moving co-ordinate systems, torque free motion of symmetric top – Rotational motion, precession of earth's axis of rotation.
5. Demonstrate the concept of periodic motion: small oscillations, normal modes and normal frequencies in solving the physical problems.
6. Learn the Coriolis force acting on falling body, Foucault's pendulum and torque free motion of symmetrical top.
7. Understand the Hamiltonian formalism in solving physics problems
8. Understand the canonical transformations, generating functions, Poisson and Lagrange brackets, canonical equations in terms of Poisson bracket notation for tackling the physical problems.
9. Use Hamilton-Jacobi theory for finding the solutions of various classical systems.
10. Understand the fundamentals of rocket propulsion, including thrust, specific impulse of a rocket engine, performance of first and second -stage rockets.
11. Learn the optimization of multi-stage rocket using Lagrange multiplier and launch site selection.

Unit	Content	Hours
I	**Lagrangian Mechanics:** Generalized coordinates, constraints, Lagrangian formalism and Lagrangian equations of motion, Hamilton's principle, derivation of Lagrange's equation from Hamilton's Principle. Symmetry and conservation laws: Conservation of linear momentum, angular momentum and energy, cyclic coordinates. Problems. **Motion in Central Force Field:** Equivalent one body problem. Two body collisions, scattering in laboratory and centre of mass frames. Motion in central force field, equation of orbit, elliptic, hyperbolic and parabolic orbits. Elastic scattering in central force field, Rutherford scattering, Problems.	**15**
II	**Motion of Rigid Body:** Fixed and moving coordinate systems. Euler angles, Euler theorem, Euler's equations of motion for a rigid body, angular momentum and kinetic energy of a rigid body. Rigid body dynamics: moment of inertia tensor, principal moments of inertia, Non-inertial frames and pseudo-forces, Coriolis force acting on falling body, Foucault's pendulum, Torque free motion of a rigid body, force-free motion of a symmetrical top – Rotational motion, precession of earth's axis of rotation. Some simple problems. **Small Oscillations:** one dimensional oscillator, two couples oscillators, normal modes and normal coordinates, general theory of small oscillations, examples of two coupled oscillators, vibrations of a linear triatomic molecules.	**15**
III	**Hamiltonian Mechanics and Brackets:** Hamiltonian formalism and Hamilton equations of motion, conservation theorem, physical significance of Hamiltonian. Variational principle, Derivation of Hamilton's equation from variational principle, Euler's equation, principle of least action. Legendre transformation, Canonical transformations, generating functions, conditions for canonical transformation, Poisson and Lagrange brackets, canonical equations in terms of Poisson bracket notation. Problems. **Hamilton Jacobi Theory:** Hamilton Jacobi equation of motion for Hamilton's principle and characteristic functions, Separation of variables, Action angle variables, Harmonic oscillator problem as example of Hamilton Jacobi method. Problems.	**15**
IV	**Rocket Dynamics:** Introduction equation of motion for variable mass – performance of single stage rocket; exhaust velocity, structure factor and mass ratio. Exhaust speed parameter, thrust equation, effect of gravity. Performance of second-stage rocket, expression for height attained by second stage rocket, optimization of multistage rocket, Lagrange multiplier, Launch site selection. Problems.	**15**

Text Books

1. Classical Mechanics: H. Goldstein, Narosa Publishing Pvt. Ltd. (1998).
2. Introduction to Classical Mechanics: R. G. Takwale & P. S. Puranik. Tata Mc Graw Hill, New Delhi (1997).

Reference Books

1. Classical Mechanics: H. Goldstein, C. Poole & J. Safko. Third Edition. Pearson Education Asia (2002).
2. Classical Mechanics: N. C. Rana and P. S. Joag, Tata McGraw Hill, New Delhi (1991).
3. Classical Dynamics of Particles and Systems: J. B. Marion, Academic Press (1964).
4. Classical Mechanics of Particles and Rigid Bodies: Kiran. C. Gupta, New Age International (1998).
5. Classical Mechanics: Dr. J. C. Upadhyaya, Himalaya Publishing House, Revised Edition (2009).
6. Classical mechanics: K. Sankara Rao, P. H. E Learning Private Limited (2008)
7. Orbital Mechanics for Engineering Students, Third Edition, Howard D. Curtis, Elsevier Ltd (2014).
8. Introduction to Rocket Science and Engineering, Second Edition, Travis S. Taylor, CRC Press, Taylor & Francis Group (2017).

Formative Assessment for Theory	
Assessment Occasion/ Type	Marks
Internal Assessment Test 1	10
Internal Assessment Test 2	10
Total	20
Formative Assessment as per Guidelines	

Discipline Specific Course (DSC)

Course Title: Basic Electronics and Communication
Course Code: A1PHY003T

Type of Course	Theory/ Practical	Credits	Instruction Hour per Week	Total No. of Lectures/ Hours/ Semester	Duration of Exam in Hours	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	Theory	04	04	60	03	20	80	100

Learning Objectives:

1. To understand the importance of operational amplifiers as basic circuit elements.
2. To understand the design of various additional electronic circuits using Op-amps.
3. To lean the fundamental properties of optical fibers and its usage in advances communication.
4. To teach the basic digital algebra and its simplification and understand the basic logic gates.

Course Outcomes:

At the end of this course, the students will be able to

1. Understand the basic working principles of operational amplifiers and its use for amplifier, integrator, differentiator, etc.
2. Gain knowledge of designing of op-amp based filter circuits and oscillators, comparators, frequency multipliers, basics of modulation and demodulation etc.
3. Appreciate the importance and working of optical fiber communication system, its applications for advanced communication.
4. Understanding of various Gates and logic circuits, sequential to form elements of digital circuits.

Unit	Content	Hours
I	**Operational Amplifier:** Introduction to Op Amp, Basic op amp circuit, 741 IC Op-Amp, open loop op-amp configurations – inverting, non-inverting and differential amplifiers, feedback configurations, voltage follower, non-inverting amplifier, inverting amplifier, Op-Amp parameters, input output voltages, common mode rejection ratio, slew rate and frequency limitations. Summing, difference, scaling and averaging amplifier. DC and AC Voltmeter, instrumentation amplifier, Integrator and differentiator, Differentiator and Integrator design and performance, Precision half wave and full wave rectifier, Clipper and Clamping circuits, Peak detector, Sample and hold Circuit.	**15**

II	**Op-amp Applications and Specialized ICs:** Active filters – types, All pass phase shifting circuits, first and second order active low and high pass filter. Band pass filter, band stop filter. Oscillators – basic principles, phase shift oscillator, Wein bridge oscillator, triangular and rectangular wave generator. Comparators and converters – basic comparator, zero crossing detector, Inverting and non-inverting Schmitt trigger, astable and monostable multivibrator. Precision voltage regulator (fixed and adjustable). IC 565 Phase locked loop, characteristics, Frequency multiplier, AM and FM demodulator.	**15**
III	**Optical Fiber Communications:** Introduction, optical fiber wave guide, ray theory transmission total internal reflection, acceptance angle, numerical aperture, skew rays, Electromagnetic mode theory, Modes in planar guide, Phase and group velocity, Types of fibers, step index fiber, graded index fiber, single mode fiber, mode field diameter and spot size, effective refractive index, photonic bandgap fibers. Intrinsic and extrinsic absorption losses, Rayleigh scattering, fiber bend loss, material dispersion and scattering effects. Preparation of optical fibers, liquid phase (melting) techniques, Plasma activated chemical vapor deposition. Structure and characteristics of multimode step index fibers, graded index fibers, single mode fibers and plastic clad fibers, optical fiber connectors, fiber alignment and joint loss, fiber splices. Light sources for OFC, LED and laser diodes, detectors p-n, p-i-n and avalanche photodiodes.	**15**
IV	**Digital Electronics:** Boolean operations and expressions, Boolean analysis of logic gates, simplification of Boolean expression. Karnaugh map: two, three and four variable maps. **Digital Logic Gates:** AND, OR, NAND and NOR gates, AND-OR and NAND-NOR implementation of Boolean Expressions. Logic gate operation with pulse waveforms. **Combinational Logic Circuits:** Adder, parallel binary adder, subtractor, parity generators and checkers, comparators, decoders, BCD to seven segment decoder, encoders, code conversion, multiplexers, demultiplexers. **Sequential Circuits:** Latches, flip flops, SR, D, JK, Master Slave JK, T flip flops, counters, synchronous and asynchronous counters, ripple counters, mod n counters, mod 3, mod 5 and mod 10 counters, registers, shift registers, timing sequences, memory units, random access memory (RAM).	**15**

Text Books

1. Operational Amplifier and Linear IC's: Robert F. Coughlin and Frederick F. Driscoll, PHI publications (1994).
2. Op Amps and linear Integrated Circuits: R. Gayakwad, PHI publications, New Delhi (2000).
3. Digital Principles and Applications: A.P. Malvino and D. Leach, TMH Publications (1991).
4. Digital fundamentals – 10th Edition: Thomas L Floyd, Pearson Education (2003).
5. Optical Fiber Communication Principles & Practice, John M. Senior, Prentice Hall International Ltd, London (1992).

Reference Books

1. Microelectronics Circuits: Adel S. Sedra and Kenneth C. Smith, Oxford University Press (1991).
2. Digital Computer fundamentals, Thomas C. Bartee, McGraw Hill Ltd. (1977).
3. Digital Logic and Computer Design: Morris Mano. Prentice Hall of India Pvt. Ltd New Delhi (2000).
4. Logic Circuit Design: Alan W. Shaw, Sanders College Publication Company (1999).

Formative Assessment for Theory	
Assessment Occasion/ Type	Marks
Internal Assessment Test 1	10
Internal Assessment Test 2	10
Total	20
Formative Assessment as per Guidelines	

Discipline Specific Course (DSC)

Course Title: Basic Condensed Matter Physics
Course Code: A1PHY004T

Type of Course	Theory/ Practical	Credits	Instruction Hour per Week	Total No. of Lectures/ Hours/ Semester	Duration of Exam in Hours	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	Theory	04	04	60	03	20	80	100

Learning Objectives:

1. To teach students the importance of condensed Matter Physics.
2. To understand the possible atomic arrangements and its concepts of real crystal lattice.
3. To teach the how solids are atomically bonded that differ their physical properties.
4. Experimental probing of atomic/molecular arraignments through X-ray diffraction.
5. To teach the concept of phonons through lattice dynamics.
6. To develop free electron theory and its contribution to physical properties of metals
7. To understand the physics of semiconductors, magnetic materials and superconductors.

Course Outcomes:

The specific outcomes of this course are as under:

1. The formation of crystalline state in solids along with the basic definitions associated with geometrical arrangement of atom in crystal can be understood.
2. The atomic arrangement in real crystals can be studied experimentally by using X-ray diffraction by introducing the concept of reciprocal lattice.
3. The crystal binding of solids through chemical bonding is an important topic to understand the strength and physical properties of materials that can be achieved by this course.
4. The behavior of materials in terms of interaction of atoms and electrons in subject to applied external fields/force can be understood.

Unit	Content	Hours
I	**Crystal Structure:** Two dimensional lattice, bases vectors, and translational vector. Unit cell, primitive and non-primitive cells and classification of crystal lattices. Crystal planes, d-spacing and Miller indices and their relationship. Symmetry elements, point groups and space groups. Symmetry elements of cubic unit cell. Examples of simple crystal structures, such as NaCl, CeCl, ZnS etc. **Crystal Diffraction and Reciprocal Lattice:** Bragg law, reciprocal lattice vectors, diffraction condition, Laue equations, Brillouin zones. Atomic form factor, structure factor and its applications to simple cases. Experimental methods of X-ray diffraction, details of powder X ray diffraction for the cubic crystal structure determination. Neutron and Electron diffraction concepts only.	**15**

II	**Crystal Binding:** Interaction between atoms, atomic pair potential. Different types of chemical bonding in solids: Ionic, covalent, metallic, van der Waals and hydrogen bondings. Crystals of inert gases: van der Waals London interaction, repulsive interaction, cohesive energy. **Ionic Crystals:** Madelung energy, Born Mayer Model, evaluation of Madelung constant for an infinite line of ions. **Lattice Vibrations and Lattice Thermal Properties:** Elastic waves, density of states of a continuous medium. Theories of specific heat: Classical, Einstein and Debye models and their limitations. Vibration of one dimensional monatomic and diatomic lattices, properties of lattice waves, concept of phonons and lattice thermal conductivity.	**15**
III	**Free Electron Model of Metals:** Free electron gas and formulation of free electron theory of metals, electrical conductivity and origin of collision time, electrical conductivity versus temperature, Mattheissen's rule. Heat capacity of free electrons, Fermi-Dirac distribution, the concept of Fermi surface, the effect of Fermi surface on electrical conductivity. Thermal conductivity of electron: Wiedemann Franz law. **Energy Bands in Solids:** Origin and magnitude of energy gap. Bloch functions. Kronig Penney model (qualitative). Number of states in a band. Distinction between metals, insulators and semiconductors. Velocity of the Bloch electron, electron dynamics in an electric field, concept of hole, dynamic effective mass of electrons and holes.	**15**
IV	**Semiconductors:** Intrinsic and extrinsic semiconductors and doping processes. Intrinsic and extrinsic carrier concentrations, position of Fermi level, electrical conductivity and mobility and their temperature dependence. Hall effect in semiconductors and its significance. **Superconductivity:** Experimental survey, qualitative ideas about BCS theory, high temperature superconductors. General applications of superconductors. **Magnetic Properties:** Classification of magnetic materials, quantum theory of paramagnetism, Curie law. Ferromagnetism and qualitative idea of Weiss' molecular field theory and Curie-Weiss law. **Defects in Solids:** Types of imperfections, Schottky and Frenkel defects and their concentration estimation under equilibrium condition.	**15**

Text Books

1. Introduction to Solid State Physics: C. Kittel. Wiley Eastern Ltd., Bangalore (1976).
2. Elementary Solid-State Physics: M.A. Omar. Addison Wesley Pvt. Ltd. New Delhi (1993)
3. Solid State Physics: A.J. Dekker, Macmillan India Ltd., Bangalore, (2000).
4. Solid State Physics: F.W.Ashcroft & N.D. Mermin. Saunders College Publishing, New York (1976).

Reference Books

1. Introduction to Solids: L.V. Azaroff. McGraw Hill inc, New york (1960).
2. Solid State and Semiconductor Physics: J.P.McKelvey. Harper and Row, Newyork (1966).
3. Elements of Solid State Physics (2nd Ed): J.P. Srivastava, PHI Learning Pvt. Ltd., New Delhi (2009).

Formative Assessment for Theory	
Assessment Occasion/ Type	Marks
Internal Assessment Test 1	10
Internal Assessment Test 2	10
Total	20
Formative Assessment as per Guidelines	

Discipline Specific Course (DSC)

Course Title: Practical – I: Electronics & Communication and Condensed Matter Physics (General)

Course Code: A1PHY005P

Type of Course	Theory/ Practical	Credits	Instruction Hour per Week	Total No. of Lectures/ Hours/ Semester	Duration of Exam in Hours	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	Practical	04	08	120	04	20	80	100

Learning Objectives:

1. To teach students to conduct basic experiments in Electronics and Condensed Matter Physics.
2. To teach how to solve the lattice structure of crystalline materials.
3. To measure fundamental parameters of materials and devices.
4. To realization of importance of operational amplifier in design of certain basic circuits.
5. To develop understanding of importance of digital electronics by certain basic experiments.

Course Outcomes:

The specific outcomes of this course are as under:

1. It helps to solve the crystal structure and lattice parameter by X-ray diffraction.
2. Various concepts around the atomic structures are cleared.
3. The experiment gives an idea on how to measure E_g of a semiconductor.
4. Designs using operational amplifier based circuits are learned.
5. Designs of various oscillators are realized.
6. Similarly, the importance of Op-amp in electronic filters is understood.
7. Significance of digital electronics for various applications is learned.

Experiments:

1. Op-Amp 741 as an adder, subtractor, differentiator and integrator.
2. Wien bridge oscillator using Op-Amp 741.
3. Triangular wave generator using op-amp 741.
4. Low pass, high –pass and band pass active filters using Op Amp 741.
5. Simplification of Boolean expressions and implementation using 2 input NAND gate IC7400.
6. Computer Programming.
7. Analysis of X ray diffraction pattern.
8. Thermistor characteristics.
9. Determination of energy gap of semiconductor by resistivity measurement (4 probe method).
10. Developing of X ray pattern for a given substance using x ray diffractometer and determination interplanar spacing.
11. Structure factor calculation of simple crystal structures.

(New experiments/assignment may be added by the Dept. of Physics, KUD)

Reference Books:

1. Microelectronics Circuits: Adel S. Sedra and Kenneth C.Smith, Oxford University Press (1991).
2. Electronic devices and circuits: R. Boylstead and Nashalsky: PHI publications (1999).
3. Electronics Principles: A.P. Malvino, TMH Publications (1984).
4. Operational Amplifier and Linear IC's: Robert F. Coughlin and Frederick F. Driscoll, PHI publications (1994).
5. Op-Amps and Linear Integrated Circuits: R. Gayakwad, PHI publications, New Delhi (2000).
6. Elementary Solid State Physics: M.A.Omar, Addison Wisley Pub. .Ltd. New Delhi (1993).
7. X ray Diffraction: B.D. Cullity, Addison Wisley Ltd. New York (1972).
8. Introduction to Solid State Physics: C. Kittel, Wiley Eastern Ltd. Bangalore (1976).
9. Laboratory Manuals

Formative Assessment for Theory	
Assessment Occasion/ Type	Marks
Internal Assessment Test 1	20
Total	20
Formative Assessment as per Guidelines	

Discipline Specific Course (DSC)

Course Title: Practical – I: Atomic & Molecular Physics and Nuclear & Particle Physics (General)

Course Code: A1PHY006P

Type of Course	Theory/ Practical	Credits	Instruction Hour per Week	Total No. of Lectures/ Hours/ Semester	Duration of Exam in Hours	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	Practical	04	08	120	04	20	80	100

Learning Objectives:

At the end of the course students will learn:

1. Understand the fundamentals of various physical phenomena and physical concepts.
2. Understand the interference and diffraction by means of He-Ne laser.
3. Know how Rydberg constant can be determined from the Hydrogen spectrum.
4. Learn about dispersion of a Grating Spectrograph.
5. Understand the Rotational analysis of HCl
6. Understanding the basics of nuclear radiations and their detection
7. to study the performance of G.M. Counter
8. to Study of the performance of Scintillation detector and scintillation spectrometers.
9. Understanding the random nature of radioactive decay.
10. To know the absorption of beta particles.

Course Outcomes:

After successful completion of the course on practicals, a student will be able to:

1. Understand the fundamentals of various physical phenomena and physical concepts.
2. Understand the interference and diffraction by means of He-Ne laser.
3. Determine the Rydberg constant from the Hydrogen spectrum.
4. Understand the dispersion of a Grating Spectrograph.
5. Understand the Rotational analysis of HCl
6. Write the Fortran program, compile and execution to solve the spectroscopy problems.
7. Get the knowledge of nuclear radiations and their decays.
8. Understand the performance and characteristics of Geiger-Muller counter for estimating the random nature of radioactive decay and attenuation of beta particles.
9. Understand the performance and characteristics of NaI(Tl) scintillation gamma ray spectrometers.

Experiments:

1. Study of Interference and Diffraction by means of He-Ne laser.
2. Determination of the Rydberg constant from the Hydrogen spectrum.
3. Study of dispersion of a Grating Spectrograph.
4. Rotational analysis of HCl.
5. Study the origin and difference in the nuclear decays and their detection.
6. Study of the performance of G.M. Counter and Proportional counter.
7. Study of the performance of Scintillation detector and scintillation spectrometers.
8. Study of the random nature of radioactive decay using radioactive source
9. Study of the absorption of beta particles.

(New experiments/assignment may be added by the Dept. of Physics, KUD)

Reference Books:

1. Advanced Practical physics: (9th Edition) B.C.Worsnop & H.T. Flint Methuen & Co. Ltd. London (1951).
2. Instrumental Methods of Analysis : (6th Edition) H.H. Willard, L.L. Merrit, J.A. Dean & F.A. Settle, J.K. Jain for CBS Publishers (1986).
3. Optics (2nd Edition) A.K. Gathak Tata Mc Graw Hill Pub. Comp. Ltd New Delhi (1977).
4. Experimental Spectroscopy (3rd ed): Ralph A. Sawyer, Dover Pub, N.Y. (1950).
5. Lab Manuals/Books/Charts.
6. Experiments in Modern Physics: A.C. Melissions academic press (NY)(1966).
7. Experiments in Nuclear Science, ORTEC Applications Note. ORTEC,(1971) (Available in Nuclear Physics Laboratory).
8. Practical Nucleonics: F.J.Pearson., and R.R. Dsborne, E7 F.N. Spon Ltd (1960).
9. The Atomic Nucleus: R.D. Evans, Tata McGraw Hill Pub.comp.Ltd (1960).
10. Nuclear Radiation Detectors: S.S.Kapoor & V.S. Ramamurthy, Wiley Eastern Ltd (1986).
11. Experimental Nucleonics: E. Bleuler and G.J. Goldsmith, Rinehart & Co. Inc. (NY). (1958).

Formative Assessment for Theory	
Assessment Occasion/ Type	Marks
Internal Assessment Test 1	20
Total	20
Formative Assessment as per Guidelines	

M.Sc. SEMESTER – II

Discipline Specific Course (DSC)

Course Title: Quantum Mechanics – I
Course Code: A2PHY007T

Type of Course	Theory/ Practical	Credits	Instruction Hour per Week	Total No. of Lectures/ Hours/ Semester	Duration of Exam in Hours	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	Theory	04	04	60	03	20	80	100

Learning Objectives:

1. To introduce the Quantum Mechanical postulates for physical systems.
2. To introduce the Quantum Mechanical concepts of measurements for physical systems.
3. To introduce the concept of Quantum Mechanics in simple microscopic systems and its connection to actual observable.
4. To understand Quantum Mechanics by solving trivial problems.
5. To teach the significance of perturbation theory and its application to energy and wave function corrections
6. To understand the problem of scattering and its critical study by Quantum Mechanics.

Course Outcomes:

At the end of the course students will learn:

1. Basic postulates of Quantum mechanics, Ehrenfest's theorem and simple applications of Quantum Mechanics.
2. Apply principles of quantum mechanics to calculate observables on known wave functions
3. Solve time-dependent and time-independent Schrödinger equation for simple potentials
4. The time-dependent and time-independent Schrödinger equation for simple potentials like for instance the harmonic oscillator and hydrogen like atoms, as well as the interaction of an electron with the electromagnetic field
5. Reduction of two body problem to single particle problem. Centre of mass and relative motions, eigen values and eigen functions.
6. Theory of time-independent perturbation theory (the case of a system with non-degenerate energy levels) its applications and theory of time-dependent perturbation theory its concept and its applications.
7. Scattering theory: Differential and total cross-section. Born approximation and its derivation of the expression for different cross-section.

Unit	Content	Hours
I	**Basic Principles:** State functions as probability amplitude and the principle of superposition; observables; Eigen functions, eigen values and orthonormalization of eigen functions, Hermitian operators; Momentum, Hamiltonian and energy operators, Schrodinger equation-Time independent and Time dependent, physical significance, Probability density and probability current density, expectation value, Ehrenfest's theorem and its physical significance, problem solutions. **Simple Applications:** Eigen values and eigen functions of free particle, particle in infinite square well and of simple harmonic oscillator by polynomial method, one dimensional barrier transmission problems: leakage of free particle through a thick rectangular potential barrier and transmission and reflection coefficients, square well potential.	**15**
II	**Spherically Symmetric Potentials**: Reduction of two body problem to a single particle problem. Center of mass and relative motions, Applications: eigen values of energy and eigen functions of Hydrogen like atom. **Angular Momentum-Spherical Harmonics:** The expression for the three Cartesian components and the square of the angular momentum, their commutation relations, expression for the operators in polar coordinates, eigen values and eigen functions in terms of polar coordinates; eigen values and eigen functions of the square and z component of angular momentum. Angular momentum and rotations.	**15**
III	**Time Independent Perturbation Theory:** Nondegenerate Energy levels, first order correction to the Energy. Application to anharmonic oscillator and to the ground state of Helium atom, problems solutions. **Time Dependent Perturbation Theory:** Concept of the theory, harmonic perturbation, transition to a continuum states, Absorption and emission of radiation, Einstein's A & B coefficients, selection rules, problems solutions.	**15**
IV	**Elastic Scattering:** Differential and total cross section, phase analysis. Significance of the partial waves and phase shifts, S wave scattering from a square well potential. The Born approximation, derivation of the expression for differential scattering cross section, condition for validity of the approximation: application to square well potential and screened coulomb potential problems solutions.	**15**

Text Books:

1. Quantum Mechanics – Theory & Applications (3rd Ed): A.K. Ghatak & S. Loknathan, MacMillan India Ltd. 91984).
2. A Text of Quantum Mechanics: P.M. Mathews &K. Venkatesan, Tata McGraw Hill, New Delhi (1982).
3. Quantum Mechanics (2nd ed): G. Aruldhas, Prentice Hall India Pvt. Ltd. New Delhi (2009).
4. Quantum Physics (3rd ed): S. Gasiorowicz, Wiley India (P) Ltd., New Delhi (2007).
5. Applied Quantum Mechanics: A.F.J levi, Cambridge University Press
6. Quantum Mechanics-concepts and Applications: Nouredine Zettili, A John Wiley and Sons, Ltd., Publication
7. Introduction to Quantum Mechanics: David J. Griffiths, Cambridge University Press (CUP) 2017

Reference Books

1. Introduction to Quantum Mechanics: L. Pauling & E. Bright Wilson, McGraw Hill, N.Y. (1935).
2. Quantum Mechanics (3rd ed): L.I. Schiff, McGraw Hill, N.Y. (1968).
3. Quantum Mechanics: E. Merzbacher, 2nd ed., Wiley, N.Y. (1970).
4. Quantum Mechanics (2nd Ed): V.K. Thankappan, new Age International (P) Ltd. (1993).
5. Quantum Physics: Eyvind H Wichman, Berkely Physics Course, Volume 4, Tata McGraw Hill Education Private Limited

Formative Assessment for Theory	
Assessment Occasion/ Type	Marks
Internal Assessment Test 1	10
Internal Assessment Test 2	10
Total	20
Formative Assessment as per Guidelines	

Discipline Specific Course (DSC)

Course Title: Basic Atomic, Laser and Molecular Physics
Course Code: A2PHY008T

Type of Course	Theory/ Practical	Credits	Instruction Hour per Week	Total No. of Lectures/ Hours/ Semester	Duration of Exam in Hours	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	Theory	04	04	60	03	20	80	100

Learning Objectives:

1. To make students to understand the interpretation of optical spectra using different theoretical models of molecules and correlate with the experimental spectra.
2. To make students to know the principles of lasers and understand the working of typical lasers and their uses in advanced frontier areas.
3. To understand the interpretation of Microwave and Mid IR spectral regions due to the diatomic molecules, their relevance in various scientific areas.

Course Outcomes:

At the end of the course, the students will learn:

1. How to interpret optical spectra using theoretical models; achieve agreement with experiment.
2. How typical lasers work, their principles and use in advanced frontier areas.
3. How to interpret Microwave and Mid IR spectral regions due to the diatomic molecules, their relevance in chemical sciences, astrophysics; planetary science.

Unit	Content	Hours
I	**Atomic Spectra and Structure:** The salient features of optical spectra due to the single-and two-valence electron atoms: Alkalis, Boron group and IIA and IIB group of elements (as in Periodic Table). The spin-orbit interactions due to the single- and two-valence electron atoms and their multiplet spectra. Determination of spectral terms (singlets, doublets, triplets, etc.) using the Vector Model. Derivation of interaction energies in LS and jj coupling schemes based on the Vector Model. The Lande′ Interval Rule; singlet and triplet splittings. Normal and Anomalous Zeeman Effect: The Zeeman pattern and its polarization properties as derived from singlet and doublet states (qualitative). Stark Effect: Stark pattern in hydrogen and its properties (qualitative).	**15**
II	**Laser Physics:** Laser principles: the Einstein coefficients, optical pumping, population inversion, and the threshold condition - the Schawlow-Townes condition for laser oscillations. Three-level and four-level laser systems. The Ruby laser and He-Ne laser systems: energy level diagrams, excitation mechanism, construction and working. Breadth of Spectral Lines (qualitative): Mechanisms; natural, Doppler, collision/pressure and Stark broadenings. Laser cooling: basic concepts, trapping techniques of neutral atoms, the Bose Einstein condensation. Atom lasers: basic ideas with illustrations.	**15**

III	**Diatomic Rotational Spectra and Structure:** The general features of experimental Far IR and Raman spectra and their empirical spectral series of typical diatomic molecules in the microwave region. Models for diatomic molecules as rigid and non-rigid rotators (simple and symmetric top): energy levels, eigen functions, thermal distribution, symmetry properties and statistical weights of rotational levels, selection rules for IR and Raman spectra and correlation with empirical series and illustrations. Applications: Determination of moments of inertia and bond lengths; Astrophysical significance of rotational spectra.	**15**
IV	**Diatomic Vibrational Spectra and Structure:** The general features of experimental IR and Raman spectra and their empirical spectral series of typical diatomic molecules in the Near/Mid IR regions. Model for diatomic molecule as Harmonic and Anharmonic oscillators: energy levels, eigenfunctions, selection rules for IR and Raman spectra and correlation with empirical series and illustrations. The Vibrating-Rotator Model: energy levels, selection rules, IR and Raman spectra, IR fine structure spectrum of a rotation-vibration band and correlation with empirical series. Applications: determination of bond lengths, rotational constants; similarly, for force constants and their correlation to covalent bonds and force-fields	**15**

Text Books

1. Introduction to Atomic Spectra: H.E. White, McGraw – Hill, Tokyo (1934) [Free soft copy available on Net].
2. Atomic Spectra: H.G.Kuhn, Longmans, Green & Co. Ltd, London & Harlow (1962) [Free soft copy available on Net].
3. Molecular Spectra; Molecular Structure (Vol I; 2nd ed): G. Herzberg, D. Van Nostrand Inc. N.Y. (1950) (Free soft copy available on Net).
4. Modern Spectroscopy (4th Ed): J.M. Hollas, John Wiley & Sons Ltd. UK 2004[Free soft copy available on Net]
5. Fundamentals of Molecular Spectroscopy: C. N. Banwell and E.M. McCash, Tata Mc Graw Hill Co., (4th revd Ed; 9th reprint, 2000)
6. Laser and Non-Linear Optics: B. B. Laud, Wiley Eastern Ltd., New Delhi (1991).
7. Laser Fundamentals: William T. Silfvast, Cambridge Univ Press, 1999.

Reference Books:

1. Fundamentals of Spectroscopy (2nd ed): B. Narayan, Allied Publishers Ltd., New Delhi (1999).
2. Physics of Atoms and Molecules – 2nd Ed., Bransden B.H. and Joachain C.J., Pearson Education, India (2006).
3. Spectroscopy (Vol. 3) : S. Walker & B. P. Strauhghan, Chapman & Hall, London (1976)
4. Laser Electronics: Joseph T. Verdeyen, Prentice-Hall of India Pvt. Ltd. New Delhi (1989).
5. Lasers: Theory & Applications: K. Thyagarajan & A. Ghatak, MacMillan India, New Delhi (1981).

Formative Assessment for Theory	
Assessment Occasion/ Type	Marks
Internal Assessment Test 1	10
Internal Assessment Test 2	10
Total	20
Formative Assessment as per Guidelines	

Discipline Specific Course (DSC)

Course Title: Basic Nuclear and Particle Physics
Course Code: A2PHY009T

Type of Course	Theory/ Practical	Credits	Instruction Hour per Week	Total No. of Lectures/ Hours/ Semester	Duration of Exam in Hours	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	Theory	04	04	60	03	20	80	100

Learning Objectives:

1. To develop the basic skill of nuclear and radiation physics.
2. To study general properties of the nucleus and nuclear models.
3. To review and provide detailed knowledge on various nuclear decays.
4. To teach the basic principles and working of different radiation detectors
5. To teach different types of nuclear reactions and familiarize reactor physics.
6. To study the elementary particles and their classification.
7. To understand the interaction of ionizing radiations with matter.
8. To discuss the applications of ionizing radiation.

Course Outcomes:

After successful completion of this course the students will be able to:

1. Describe the basic properties of nucleus, its structure and different models that explain the static and dynamical properties of a nucleus.
2. Able to predict the spin, parity and magnetic dipole moment and electric quadrupole moment of nucleus.
3. Understand the experimental determination of magnetic moment by Rabi's atomic beam method and Weizsacker's semi empirical mass formula.
4. Understand the phenomenon of radioactive decays of alpha and beta particles and gamma rays, their detailed formalism and outcomes.
5. Learn about Pauli's neutrino hypothesis and Fermi's theory of beta decay and non-conservation of parity in beta decay.
6. Acquire knowledge about various type of radiation detectors used in nuclear physics experiments, unique properties of different detectors and their applications.
7. Differentiate between different types of nuclear reactions, Q-values, relevant aspects associated with nuclear reactions and kinematics of such reactions.
8. Learn about the condition for controlled chain reaction in different nuclear reactors and energy release in fission reactions.
9. Know about different elementary particles their classifications and quark model to understand the fundamental forces of nature and classification.
10. Understand the stopping power of different energetic charged particles in a medium and mechanisms of interaction of gamma photon with matter.
11. Understand the applications of radioisotopes in trace elemental analysis, in cancer treatment, agriculture and industry.

Unit	Content	Hours
I	**General Properties:** Constituents of nucleus and their properties. Binding energy and separation energy. Charge and charge distribution, Radius of nucleus by mirror nuclei method, by high energy electron scattering method, by X-rays from muonic atom. **Nuclear Spin and Magnetic Moment:** Spin, parity and statistics, magnetic dipole moment, magnetic moment of odd-A nucleus, experimental determination of magnetic moment by Rabi's atomic beam method. **Nuclear Quadrupole Moment:** Electric quadrupole moment of nucleus, Prolate and Oblate structures, quantum mechanical description. **Nuclear Models:** Liquid drop model, Weizsacker's semi empirical mass formula, stability of nuclei against beta decay, stability against spontaneous fission, mass parabola. Fermi gas model, Fermi energy and kinetic energy. Nuclear shell model and magic numbers. Problems	**15**
II	**Alpha Decay:** Gamow's theory of alpha decay, quantum mechanical tunneling, relation between mean life and decay energy, Hindrance factor. **Beta Decay:** Energetics of beta decay, continuous beta ray spectrum, Pauli neutrino hypothesis, Fermi's theory of beta decay (derivation), Fermi Kurie plot, ft-values and selection rules, non-conservation of parity in beta decay. **Gamma Decay:** Gamma transitions in nuclei, multipole radiation, selection rules, classification of gamma transitions. Internal conversion (qualitative) **Radiation Detectors:** Gas filled counters, general features, ionization chamber, proportional counter and GM counter. NaI(Tl) scintillation gamma ray spectrometer, semiconductor detector for detection of X ray and gamma radiation. Problems.	**15**
III	**Nuclear Reaction:** Types of nuclear reactions. conservation laws, laboratory and center of mass systems. Q-value of a nuclear reaction and relation between Q-value and energy of outgoing particle, threshold energy. Compound nucleus model and its experimental verification. Briet-Wigner formula (qualitative). **Reactor Physics:** Fission chain reaction**,** condition for controlled chain reaction, energy release in fission, four factor formula, thermal reactor, fast breeder reactor. **Elementary Particles:** General features and classification of fundamental interactions; conservation laws, quantum numbers: charge, spin, parity, isospin, strangeness, etc. classification of elementary particles as leptons, mesons and baryons, Quark model (qualitative). Problems.	**15**
IV	**Interactions of Radiation with Matter and Nuclear Radiation:** Photoelectric effect, Compton scattering and pair production, linear and mass attenuation coefficients of gamma rays. Mossbauer effect; Resonance scattering of gamma rays, experimental technique, simple applications. Energy loss of heavy charged particles; ionization, radiation processes, Bethe-Bloch formula, range-energy relations, applications. Energy loss of fast electrons; ionization, excitation and radiation process (Bremsstrahlung) (qualitative only). Problems. **Nuclear Radiation:** radiation exposure, absorbed dose, equivalent dose and effective dose, dose limits. Applications of radioisotopes in medicine and in cancer treatment, agriculture, industry and in trace elemental analysis, radiation shielding.	**15**

Text Books:

1. Nuclei and Particles: E. Segre –The Benjamin Publishing, Pvt Ltd (1977).
2. Introductory Nuclear Physics: K.S. Krane John Wiley & Sons (1987).
3. Atomic and Nuclear Physics: Vol. II S.N.Goshal S. Chand and Company (1996).
4. Nuclear Physics: D.C.Tayal Himalaya Publishing House(2009)
5. Nuclear and Particle Physics: S.L.Kakani, ShubhraKakaniVira Books(2008)
6. Environmental radioactivity: Eisenbud M, Academic Press (1987)

Reference Books:

1. The Atomic Nucleus: R.D. Evans – Tata McGraw Hill New Delhi (1992).
2. Physics of Nuclei and Particles: Marmer and E.Sheldon,Vol.II Academic press (1970).
3. Physics of Nuclear Reactors: S.Garag, F.Ahmed and L.S. Kothari. – Tata McGraw Hill New Delhi (1986).
4. Introductory Nuclear Physics: Samuel Wong Prentice Hall (1996).
5. Fundamentals of Nuclear Physics: N.A.Jelly Cambridge University Press (1990).
6. Introduction to Nuclear Physics: Harald A. Enge Addison –Wiseley (1996).
7. Knoll G F, Radiation Detection and Measurement‟, II Edn. (John Wiley, 1989)
8. Introduction to Nuclear and Particle Physics: V.K.Mittal, R.C. Verma, S.C. Gupta PHI Learning Limited (2009)
9. Radiation detectors: Kapoor S S and Ramamurthy V S Wiley Eastern (1986)

Formative Assessment for Theory	
Assessment Occasion/ Type	Marks
Internal Assessment Test 1	10
Internal Assessment Test 2	10
Total	20
Formative Assessment as per Guidelines	

Open Elective Course (OEC)

Course Title: Open Elective Course – I: Modern Physics
Course Code: A2PHY201T

Type of Course	Theory/ Practical	Credits	Instruction Hour per Week	Total No. of Lectures/ Hours/ Semester	Duration of Exam in Hours	Formative Assessment Marks	Summative Assessment Marks	Total Marks
OEC	Theory	04	04	60	03	20	80	100

Course Objectives:

1. To teach the basic concepts of modern physics for students with a general background.
2. To make it to understand the important experimental discoveries that led to the development of quantum mechanics.
3. To teach the significance of other branches of physics for better understanding of the Modern Physics.
4. Basics of Spectroscopy, Nuclear Physics and Condensed Matter Physics etc are made clear.

Course Outcomes:

After successful completion of this course a student will be able to:

1. Learn nature of black body spectrum, classical radiation laws and their limitations; Laws of photoelectric effect and Einstein photoelectric equation and Compton effect.
2. Understand the atomic structure, matter waves, Quantum Physics and its applications.
3. Acquire knowledge about nuclear structure and molecular structure, quantum statistics, F-D and B-E distributions. Laser action and its characteristics.
4. Acquire knowledge about nuclear fission/fusion nuclear reactor stellar energy and their applications.

Unit	Content	Hours
I	**Blackbody Radiation:** Nature of Blackbody spectrum; classical radiation laws and their limitations; Planck's radiation law and quantum hypothesis. Simple examples/problems. **The Photoelectric Effect:** Apparatus used to study the Photoelectric Effect; laws of Photoelectric Effect; Einstein Photoelectric Equation. Simple examples. **X-Rays:** Nature and production of X rays; the Bragg law; Bragg X ray crystal spectrometer. **The Compton Effect:** X ray Compton scattering from an electron; experimental set up for Compton scattering. Simple problems.	**15**

II	**Atomic Structure:** Hydrogen spectrum; the Bohr model; experimental measurement of the Rydberg constant; Franck Hertz experiment. **Matter Waves:** The de Broglie wavelength and its relation with the Bohr model; Davisson Germer experiment. Heisenberg Uncertainty principle: Momentum position and Energy time relations. Simple examples. **Quantum Physics:** Idea of wave function and probability. One dimensional Schrödinger wave equation: Its application to the particle in a box and Hydrogen atom; energies and wave functions. **Vector Model:** Space quantization: Orbital angular moment and magnetic moment; Spin angular moment and magnetic moment; Stern Gerlach experiment. States of Hydrogen in terms of n, l, ml. The normal Zeeman Effect; experimental set up for Zeeman effect. Simple problems.	**15**
III	**Statistical Physics:** Distinguishability and Indistinguishability; Maxwell Boltzmann distribution for gas molecules; V_{rms}; Equipartition theorem. Quantum statistics: F D and B E distributions. **Molecular Structure:** Bonding mechanisms: Ionic bonds; Covalent bonds; the Hydrogen bond; Van der Waals bonds. Molecular vibration and rotation spectra. Molecular orbitals: Hydrogen molecular ion and molecule; bonding in complex molecules. **Solid State Physics:** Ionic solids; covalent solids; metallic solids; molecular crystals; amorphous solids. Classical models of electrical and heat conductivities in solids; Ohm's Law; Wiedemann Franz law; the quantum view point. **Lasers:** Absorption, Spontaneous and Stimulated emissions; Population inversion; laser action; typical gas (He Ne/CO_2) characteristics.	**15**
IV	Magnetism; Magnetic moment; Magnetization. Magnetic materials: Diamagnetic, paramagnetic and ferromagnetic materials. Superconductivity phenomenon. **Nuclear Structure:** Nuclear properties: Charge, Mass, Size and Structure; Nuclear spin and magnetic moment; Nuclear Magnetic Resonance (NMR) phenomenon. Binding energy and nuclear forces. The liquid drop model. Radioactivity: Decay constant, Half-life. **Nuclear Fission/Fusion:** Fission – Basic process; a simple model; a typical nuclear reactor. Fusion: basic process; stellar energy. **Relativity:** The Michelson Morley experiment. Postulates of Special theory of Relativity; Time dilation; Length contraction; Simultaneity of events; $E = mc^2$.	**15**

Text Books

1. Modern Physics (2nd Ed) Serway, Moses and Moyer, Saunders College Pub, 1997.
2. Fundamentals of Physics extended with Modern Physics (4th Ed) Halliday, Resnick and Walker, John Wiley, 1993.

Formative Assessment for Theory	
Assessment Occasion/ Type	Marks
Internal Assessment Test 1	10
Internal Assessment Test 2	10
Total	20
Formative Assessment as per Guidelines	

Discipline Specific Course (DSC)

Course Title: Practical – III: Electronics & Communication and Condensed Matter Physics (General)

Course Code: A2PHY010P

Type of Course	Theory/ Practical	Credits	Instruction Hour per Week	Total No. of Lectures/ Hours/ Semester	Duration of Exam in Hours	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	Practical	04	08	120	04	20	80	100

Learning Objectives:

1. To teach students to conduct basic experiments in Electronics and Condensed Matter Physics.
2. To design and study circuits relevant to digital electronics.
3. Understanding of digital to analog and vice-versa electronic circuits.
4. Determination of energy gap of a semiconductor using pn-junction.
5. Measurements of type, carrier density, and mobility by combining Hall effect and electrical conductivity experiments.

Course Outcomes:

The specific outcomes of this course are as under:

1. Students learn to measure the Hall effect which in turn helps to measure the basic parameters such as carrier density, sign of carriers and mobility of charge carriers in a semiconductor.
2. It helps to explore the temperature dependent properties of a diode estimate the energy gap of a semiconductor.
3. The indexing of cubic patterns and calculation of lattice parameters is possible.

Experiments:

1. Study of triggered SR, JK and D-flip-flops.
2. Ripple counter and Shift Register using JK flip-flop.
3. Regulated power supply using 78xx integrated circuits.
4. R 2R ladder network D/A converter
5. Fortran Programming using Fortran 77.
6. Hall Effect and Hall mobility in semiconductors.
7. Determination of energy gap by reverse saturation current of pn-junction.
8. Computer programming using Fortran 77.
9. Developing of X-ray pattern for a cubic lattice using X-ray diffractometer and indexing of the pattern.

(New experiments/assignment may be added by the Dept. of Physics, KUD)

Reference Books:

1. Microelectronics Circuits: Adel S.Sedra and Kenneth C.Smith, Oxford University, Press (1991).
2. Electronic devices and circuits: R. Boylstead and Nashalsky : PHI publications (1999).
3. Electronic Principles: A.P. Malvino, TMH Publications (1984).
4. Operational Amplifier and Linear IC's: Robert F. Coughlin and Frederick F. Driscoll, PHI publications (1994).
5. Op Amps and Linear Integrated Circuits: R. Gayakwad, PHI publications, New Delhi (2000).
6. Elementary Solid State Physics: M.A. Omar, Addison Wesley Pub. Ltd. New Delhi (1993).
7. X ray Diffraction: B.D. Cullity, Addison Wesley, Ltd. New York (1972).
8. Introduction to Solid State Physics: C. Kittel, Wiley Eastern Ltd. Bangalore (1976).
9. Laboratory Manuals.

Formative Assessment for Theory	
Assessment Occasion/ Type	Marks
Internal Assessment Test 1	20
Total	20
Formative Assessment as per Guidelines	

Discipline Specific Course (DSC)

Course Title: Practical – IV: Atomic & Molecular Physics and Nuclear & Particle Physics (General)

Course Code: A2PHY011P

Type of Course	Theory/ Practical	Credits	Instruction Hour per Week	Total No. of Lectures/ Hours/ Semester	Duration of Exam in Hours	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	Practical	04	08	120	04	20	80	100

Learning Objectives:

At the end of the course students will learn:

1. Understand the production and analysis of elliptically polarized light.
2. Understand the Beer's Law.
3. Understand the dispersion spectra of radiations through glass prism spectrograph.
4. Understand how vibrational potential functions of the diatomic molecule can be calculated
5. on calibrating Nal (TI) gamma ray spectrometer and its performance.
6. Understanding the attenuation of gamma rays in matter
7. To study the semi-empirical mass formula, using Python computer programming.

Course Outcomes:

After successful completion of the course on practicals, the students will be able to:

1. Demonstrate the production and analysis of elliptically polarized light.
2. Understand the Beer's Law to measure the fraction of the incident light transmitted through a solution.
3. Understand the dispersion spectra of radiations using glass prism spectrograph.
4. Understand the calculation of vibrational potential functions of the diatomic molecule.
5. Understand the inverse square law using nuclear radiations
6. Acquire practical knowledge on calibrating Nal (TI) gamma ray spectrometer and to determine the energy of a given gamma ray source and calculate the energy resolution.
7. Understand the semi-empirical mass formula to calculate the binding energy of any nucleus using Fortran Python computer programming.

Experiments:

1. Study of Elliptically Polarized Light
2. Study of Beer's law
3. Study of Dispersion of a Glass Prism Spectrograph.
4. Study of vibrational potential functions of the diatomic molecule
5. Stefan's constant of Radiation: High resistance by leakage method
6. Study of gamma ray spectrum obtained in Nal (TI) detector spectrometer.
7. Study of attenuation of gamma rays in matter.
8. computer programming using Python programming
9. Inverse square law

(New experiments/assignment may be added by the Dept. of Physics, KUD)

Reference Books:

1. Advanced Practical Physics: (9th Edition) B. C Worsnop & H.T. Flint, Methuen & Co. Ltd. onion (1951)
2. Instrumental Methods of Analysis: (6th Edition) H. H. Willard, L. L. Merit, J. A. Dean & F. A. Settle, J. K. Jain for CBS Publishers (1986)
3. Optics: (2nd Edition) A. K. Gathak Tata Mc Graw Hill Pub. Comp. Ltd New Delhi (1977)
4. Lab Manuals / Books / Charts.
5. Experiments in Modern Physics: A C. Melissions, Academic press (N.Y.) (1966).
6. Experiments in Nuclear Science ORTEC Application Note ORTEC, (1971) (Available in Nuclear Physics Laboratory)
7. Practical Nucleonics: F.J. Pearson., and R.R. Osborne, E & F.N. Spon Ltd., London (1960)
8. The Atomic Nucleus: R.D. Evans Tata Mc Graw Hill Pub. Comp. Ltd., (1960)
9. Nuclear Radiation Detectors: S.S. Kapoor and V.S. Ramamurthy, Wiley Eastern Limited (1986)
10. Experimental Nucleonics: E Bleuler and G.J. Goldsmith, Rinehart & Co, Inc. (NY) (1958).

Formative Assessment for Theory	
Assessment Occasion/ Type	Marks
Internal Assessment Test 1	20
Total	20
Formative Assessment as per Guidelines	

M.Sc. SEMESTER – III

Discipline Specific Course (DSC)

Course Title: Quantum Mechanics – II
Course Code: A3PHY012T

Type of Course	Theory/ Practical	Credits	Instruction Hour per Week	Total No. of Lectures/ Hours/ Semester	Duration of Exam in Hours	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	Theory	04	04	60	03	20	80	100

Learning Objectives:

1. To study Linear vector Algebra and quantum dynamics.
2. To study angular momentum, its operators, commutation relations, and ladder operators,
3. To study theory of addition of angular two angular momenta, Clebsch Gordan coefficients.
4. To study approximation methods, First order stationary perturbation theory, WKB approximation and variational method with applications.
5. To study relativistic quantum mechanics, Klein-Gordon equation, Dirac's relativistic theory for free particle, Zitterbewegung, Dirac equation in electromagnetic potentials and magnetic moment.
6. To study Dirac equation for a central field; the hydrogen atom: energy levels and fine structure

Course Outcomes:

1. Learn fundamental aspects of quantum mechanics in the formalism of linear vector algebra
2. Learn different aspects of angular momentum used in theoretical models to understand variety of physical problems.
3. Learn different approximate methods used for solving higher problems
4. Learn relativistic quantum mechanics, applicable for spin zero and spin ½ particles

Unit	Content	Hours
I	**Linear Vector Algebra:** Linear Vectors space, Orthonormality, linear independence. Operators Eigen values, eigenvectors; Hermitian, Unitary and Projection operators. Bra and Ket notation for vectors. The elements of Representation Theory. Idea of Measurements, Observables and generalized uncertainty relation. Coordinate and momentum representations. Quantum Poisson Bracket. **Quantum Dynamics:** Schrödinger and Heisenberg pictures; Interaction picture; the Heisenberg	15

	equation of motion. Linear harmonic oscillator problem by matrix method.	
II	**Angular Momentum:** Introduction, angular momentum operator and its representation, Eigen values and eigen functions of L_2 , commutation relations, Angular momentum and rotations. Bra and Ket representation, Eigen values, ladder operators, Eigenvectors of J^2 and J_z . Angular momentum matrices for j=1/2 and j=1. Pauli wave function and equation, Theory of addition of two angular momenta, Clebsch Gordan coefficients, allowed values of j, singlet and triplet states (qualitative).	**15**
III	**Approximation Methods:** First order stationary perturbation theory for a degenerate case; the secular equation; applications: particle in an infinitely deep potential well subject to perturbing potential and, Stark effect in hydrogen atom; Second order perturbation theory and its application to a linear harmonic oscillator subject to a potential. W.K.B. approximation: Connection formulas; application to a potential well and alpha decay. The Variation method and its application to the ground state of hydrogen atom and helium atom.	**15**
IV	**Relativistic Quantum Mechanics:** Klein–Gordon equation. Dirac's relativistic equation for a free particle: commutation relations and matrices for and; free particle solutions; probability charge and current densities; positive and negative energy states; the spin of the Dirac particle, Zitterbewegung. Dirac equation in electromagnetic potentials and magnetic moment. Dirac equation for a central field; the hydrogen atom: energy levels and fine structure (without derivation).	**15**

Text Books

1. Quantum Mechanics (2nd Edition) : L. I. Schiff, McGraw – Hill Co, New York (1955)
2. Quantum Mechanics (Vol. I) : A. Messiah, North Holland Pub Co, Amsterdam (1962)
3. Quantum Mechanics – Theory and Applications (3rd Edition): A. Ghatak and S. Lokanathan, MacMillan India Ltd. New Delhi (1984)
4. A Text book of quantum Mechanics: P. M. Mathews and K. Venkateshan, Tata Mc Graw - Hill, New Delhi (1987).

Reference Books

1. The Principles of Quantum Mechanics (4th Edition) : P.A.M. Dirac, Oxford Univ Press, New York (1958)

2. Quantum Mechanics (1st Edition): V. K. Thankappan, New Age Intl. Pvt. Ltd., New Delhi (1985)
3. Quantum Mechanics : E. Merzbacher., John Wiley, New York (1970)
4. Modern Quantum Mechanics : J. J. Sakurai, Addison Wesley, Massachusetts (1994)
5. Applied Quantum Mechanics: A.F.J Levi, Cambridge Univ Press, 2003.

Formative Assessment for Theory	
Assessment Occasion/ Type	Marks
Internal Assessment Test 1	10
Internal Assessment Test 2	10
Total	20
Formative Assessment as per Guidelines	

Discipline Specific Elective (DSE)

Course Title: Atomic and Diatomic Molecular Spectra
Course Code: A3PHY101AT

Type of Course	Theory/ Practical	Credits	Instruction Hour per Week	Total No. of Lectures/ Hours/ Semester	Duration of Exam in Hours	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSE	Theory	04	04	60	03	20	80	100

Learning Objectives:

1. To make students to understand the application of theoretical models to the interpretation of atomic spectra.

2. To learn the electronic structure of atoms under the influence of electric & magnetic fields.
3. To understand the diatomic molecular states, electronic, vibrational & rotation spectra and the application to the interpretation of the spectra.

Course Outcomes:

The specific outcomes of this course are as under:

1. Students will learn application of theoretical models to the interpretation of atomic spectra in agreement with experiment.
2. Electronic structure of atoms under the influence of electric & magnetic fields.
3. Application of theoretical models to the interpretation of diatomic molecular states, electronic, vibrational & rotation spectra in agreement with experiment.
4. Relevance of these spectra in understanding atmosphere, comets, stars and inter-galactic matter.

Unit	Content	Hours
I	**One electron atoms: Fine structure and Hyperfine structure:** **Fine structure of hydrogenic atoms:** (quantum mechanical treatment) energy shifts due to relativistic and spin orbit corrections, fine structure splitting (hydrogen atom), fine structure and intensities of spectral lines. The Lamb shift. **Hyperfine structure and isotope shifts:** magnetic dipole hyperfine structure; energy shift, hyperfine structure multiplet, hyperfine transitions in hydrogen, isotope shift.	15
II	**Interaction of One electron Atoms with External Electric and Magnetic fields:** (Quantum mechanical treatment) The Stark effect-first order correction to energy and eigen states: splitting of the degenerate level of hydrogen; the Zeeman effect: Normal Zeeman effect-magnetic interaction energy, selection rules, Lorentz triplet, polarization states; the Paschen-Back effect (qualititative);	

	anomalous Zeeman effect magnetic interaction energy, selection rules, splitting of levels in hydrogen atom.	15
III	**Elementary discussion of electronic states:** Electronic energy and Total energy, Born- Oppenheimer approximation. Symmetry properties of electronic eigen functions. Vibrational structure of electronic bands; Progressions and Sequences, isotope effect, Deslandres' table; Intensity distribution in the vibrational structure of electronic bands; the Franck-Condon principle (absorption), Dissociation energy. Molecular orbital theory of H_2^+ and H_2 molecules.	15
IV	**Finer details about electronic states and electronic transitions:** Coupling of Rotation and Electronic Motion: Coupling of rotation and electronic motion in diatomic molecules. Hund's coupling cases (case a and case b) Spin uncoupling, Lambda doubling, symmetry properties of rotational levels of Σ and Π electronic states. Types of allowed electronic transitions; selection rules, Rotational structure of bands due to Σ–Σ, Π–Σ, Σ–Π and Π–Π transitions of singlet multiplicity, P, Q, R branches; the Fortrat diagram; combination relations; evaluation of rotational constants.	15

Text Books:

1. Physics of Atoms and Molecules (2^{nd} ed): Bransden B.H. and Joachain C.J., Pearson Education, India (2006)
2. Atoms & Molecules : Mitchel Weissbluth, Academic Press, N. Y. (1982)
3. Molecular Spectra & Molecular Structure(Vol I): G.Herzberg, D. Van Nostrand Co Princeton, N.J. (1945)
4. Physical Chemistry; A Molecular approach: Donald A. McQuarrie and John D. Simon, University Science Book(USA), 1998(1^{st} edition) (Reprinted-2010)
5. Modern Spectroscopy (4^{th} Ed): J.M. Hollas, John Wiley & Sons Ltd. UK 2004.

Reference Books:

1. Introduction to Atomic Spectra: H.E. White, McGraw – Hill, Tokyo (1934)
2. Quantum Chemistry: Ira Levine, Prentice – Hall of India, New Delhi (1991)

3. Fundamentals of Spectroscopy (2nd ed): B. Narayan, Allied Publishers Ltd., New Delhi, (1999).
4. Spectroscopy (Vol. 3):S. Walker & B. P. Strauhghan, Chapman & Hall, Lon (1976).

Formative Assessment for Theory	
Assessment Occasion/ Type	Marks
Internal Assessment Test 1	10
Internal Assessment Test 2	10
Total	20
Formative Assessment as per Guidelines	

Discipline Specific Elective (DSE)

Course Title: Electron and Ion Transport
Course Code: A3PHY101BT

Type of Course	Theory/ Practical	Credits	Instruction Hour per Week	Total No. of Lectures/ Hours/ Semester	Duration of Exam in Hours	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSE	Theory	04	04	60	03	20	80	100

Learning Objectives:

1. To teach students the theories of charge transport in solids.

2. To understand fundamental concepts of electronic structure and periodic potentials in solids.
3. To build theoretical modeling for electron transport in solids.
4. To understand experimental probes that measure electronic states and Fermi surfaces in solids.
5. To teach the concept of ion transport and distinguish it from electron transport.

Course Outcomes:

The specific outcomes of this course are as under:

1. Formation of electron structures and associated concepts can be understood.
2. Fermi surface concepts and its experimental measurements can be understood.
3. Helps to understand the electron transport by the Boltzmann generalized theory.
4. Mechanisms of atomic diffusion and ion transport can be understood.

Unit	Content	Hours
I	**Periodic Structures:** Reciprocal lattice and its properties, periodic potential, Bloch theorem, construction of Brillouin zones, symmetry properties of energy function, extended, reduces and periodic zone schemes, Born von Karman boundary conditions and its significance, counting of states and effective mass of electron. Energy band calculations: Nearly free electron model, discontinuity at zone boundary, energy gap and Bragg reflection. The tight binding approximation, band width and effective mass in linear lattice and cubic lattices. Augmented Plane Wave (APW) and k.p. methods. Conductors, semiconductors and insulators.	15
II	**Fermi Surface Studies:** Extended, reduced and periodic zone schemes. Construction of Fermi surface in square lattice, Harrison construction, slope of bands at zone boundary, electron orbits, hole orbits and open orbits. Effect of electric field on Fermi surface, effect of magnetic field on Fermi surface, and quantization of electron orbits, Landau levels. Experimental study of Fermi surface: Anomalous skin effect (Azbel-Kaner effect), cyclotron resonance and de Hass-van Alphen effect, external orbits.	15
III	**Electrical Transport in Metals and Semiconductors:** Boltzmann transport	

	equation, linearized Boltzmann equation, derivation of electrical conductivity, relaxation time approximation, thermal conductivity, and thermoelectric effects. Scattering by impurities and lattice vibrations (phonons), Mattheisen's rule, temperature dependence of resistivity and residual resistance.	15
IV	**Atomic Diffusion and Ionic Conductivity in Solids:** Diffusion in solids, Fick's first and second laws of diffusion, steady sate solutions, application to semiconductors. Diffusion mechanisms, random walk treatment for the diffusion process, diffusion in alkali halides and ionic conductivity in solids, experimental measurements of ionic conductivity. Diffusion and ionic conductivity, fast ionic (superionic) conductors and their applications.	15

Text Books:

1. Solid State Physics: Structure Properties of Materials: M.A. Wahab, Narosa Publishing House Pvt. Ltd. 3rd Edition (2015).
2. Principles of Theory of Solids: J. M. Ziman, Cambridge University Press, (1972).
3. Introduction to Solid State Physics: C. Kittel, Wiley Eastern Ltd, Bangalore (1976).
4. Elementary Solid-State Physics: M.A. Omar. Addison Wesley Pvt. Ltd. New Delhi (1993).
5. Solid State Physics: A.J. Dekker, Macmillan India Ltd., Bangalore, (2000).
6. Solid State Physics: J. D. Patterson and B.C. Bailey, Springer Verlag, Berlin (2007)

References Books:

1. Physics of Solids: F. C. Brown, Benjamin Inc. Amsterdam (1967).
2. Elements of Solid State Physics (2nd Ed): J.P. Srivastava, PHI Learning Pvt. Ltd., New Delhi (2009)
3. Solid State Physics: N. W. Aschroft and A. D. Mermin, Saunders College Publishing New York (1976).

Formative Assessment for Theory

Assessment Occasion/ Type	Marks
Internal Assessment Test 1	10
Internal Assessment Test 2	10
Total	20
Formative Assessment as per Guidelines	

Discipline Specific Elective (DSE)

Course Title: Transmission Lines, Waveguides and Satellite Communication
Course Code: A3PHY101CT

Type of Course	Theory/ Practical	Credits	Instruction Hour per Week	Total No. of Lectures/ Hours/ Semester	Duration of Exam in Hours	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSE	Theory	04	04	60	03	20	80	100

Learning objectives:

1. Understand and analyze electrical energy transmission and wired communication systems.
2. Explore high-frequency transmission lines, waveguides, and antenna applications.
3. Apply theory to practical problems in signal and satellite communication.

Course Outcomes:

At the end of this course, the students will be able to

1. Learn transmission of electrical energy from one point to another and will be able to analyze the working of different types of transmission lines and also clear understanding of working of wired telephone communication system.
2. Working of transmission lines at higher frequencies such as Radio Frequencies which helps student to appreciate the use of transmission lines in video/picture transmission.
3. Get a comprehensive picture of signal transmission, analyzing various waveguides as well as antennas.
4. Gain knowledge of how satellites communicate with ground stations and help in appreciating various applications.
5. Will be able to implement the above practically with the help of Numerical problems solving.

Unit	Content	Hours
I	**Transmission Lines:** Line parameters, inductance and capacitance of open wire and coaxial line, line of cascaded sections, transmission line general solution, physical significance of the equations, the infinite line, wavelength, velocity of propagation, wave form distortion, distortion less line, telephone cable, induction loading of telephone cable, reflection of line not terminated with characteristic impedance, open and short circuited lines, insertion losses.	15
II	**Lines at RF**: Parameters of open wire line at high frequencies, parameter of co axial cable at high frequencies, constants of lines of zero dissipation, voltage and current on dissipation less lines, standing wave ratio, impedance of open and short circuit lines, the ¼ wave line, ½ wave line, impedance matching of ½ wave	

	line, single stub matching, Circle diagram for the dissipationless line and its applications.	15
III	**Waveguides**: Introduction, Reflection of waves from conducting plane, Characteristics 0f parallel-plane and rectangular waveguides, Methods of impedance matching and tuning. Solutions of wave equations in rectangular and cylindrical coordinates, TE and TM modes in rectangular and cylindrical wave guides, characteristics of rectangular and circular wave guides. **Antennas:** Hertzian dipole, Current and voltage distributions Resonant antennas, radiation patterns, and length calculations, Non-resonant antennas, Antenna gain and effective radiated power, Radiation measurement and field intensity, Antenna resistance, Bandwidth, beam width, and polarization, Ungrounded antennas, Grounded antennas, Grounding systems, Effects of antenna height, loop antennas, phased arrays, antenna as aperture, different types of apertures, Effective area of antenna, Half-wave dipole antenna, UHF and microwave antennas: antennas with parabolic reflectors, horn antennas, lens antennas. Principles of pattern multiplication, phased arrays, Yagi Uda antenna, helical antenna.	15
IV	**Satellite Communication**: Introduction, Kepler's laws, orbits, geostationary orbit. Power systems, atmospheric losses, ionospheric effects, attitude control, satellite station keeping, antenna look angles, limits of visibility, frequency plans and polarization, transponders, up link and down link power budget calculations, digital carrier transmission, multiple access methods, fixed and mobile satellite service, earth stations, INSAT.	15

Text Books

1. Networks, Lines and Fields: J. D. Ryder, Prentice Hall India Pvt., Ltd., New Delhi (1995)
2. Electronic communications, 4th edition: Dennis Roddy and John Coolen, Prentice – Hall of India Pvt. Ltd. New Delhi (1997)
3. Electronic Communication systems – 4th edition: George Kennedy and Bernard Davis, Tata McGraw – Hill Publishing Company Ltd., New Delhi (1999).

4. Satellite communication – 3rd edition, Dennis Roddy, McGraw – Hill Publishing Company Ltd., New Delhi (2001)

References Books

1. Communications Systems: Simon Haykin, Wiley Eastern Ltd., New Delhi
2. Radio Engineering: G. K. Mittal, Khanna Publishers, Delhi (1998)
3. Modern Communication Systems – Principles and Applications : Leon W. Couch II, Prentice Hall of India Pvt. Ltd. New Delhi (1998)

Formative Assessment for Theory	
Assessment Occasion/ Type	Marks
Internal Assessment Test 1	10
Internal Assessment Test 2	10
Total	20
Formative Assessment as per Guidelines	

Discipline Specific Elective (DSE)

Course Title: Nuclear Properties and Elementary Particles
Course Code: A3PHY101DT

Type of Course	Theory/ Practical	Credits	Instruction Hour per Week	Total No. of Lectures/ Hours/ Semester	Duration of Exam in Hours	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSE	Theory	04	04	60	03	20	80	100

Learning Objectives:

1. To study the distribution of charge on the nucleus and nucleons in terms of electron scattering experiments
2. To study the departure of the nuclear charge distribution from spherical symmetry in terms of quadrupole moment
3. To study the magnetic dipole moments of nuclei in terms of currents circulating in the nuclei due to the motion of the protons.
4. To study the characteristics of nuclear force in terms of deuteron problem.
5. To study the production and properties of elementary particles.

Course Outcomes:

1. Learn the scattering phenomena using high energy electrons on nucleus to understand the electric and magnetic form factors of protons, and magnetic form factor of neutron.
2. Learn electric quadrupole moment due to single nucleon in a state J and magnetic dipole moment for odd proton and neutron using extreme single particle model.
3. Learn the theory of deuteron and explore its ground state properties to understand charge independent of nuclear force.
4. Learn the range of tensor interaction using quadrupole moment to understand the saturation of nuclear forces.
5. Learn the n-p and p-p scattering to understand the spin dependence of nuclear force.
6. Learn symmetry classification of elementary particles and quark structure of mesons.

Unit	Content	Hours
I	**Basic Properties:** Scattering of high energy electrons by nucleus; Expression for Mott Scattering, differential cross section, form factor, charge distribution in nuclei, Scattering of high energy electrons by nucleons; Expression for Rosenbluth formula, electric and magnetic form factors of protons, the magnetic form factor of neutron, their distribution in nucleon. **Electric Quadrupole Moment:** Expression for axial quadrupole moment, quadrupole moment of spheroidal nucleus. Quadruple moment due to single nucleon is a state J. Magnetic dipole moment: Nuclear g factor for neutron and proton, expression for g factor for a nucleon in a state J in special cases for odd proton and odd neutron on extreme single particle model, Schmidt limits.	15

II	**Nuclear Forces:** Characteristics of nuclear forces, deuteron problem, basic properties, ground state of deuteron for square well potential, relation between the range and depth of potential. Non existence of excited states, basic properties of non-central force, deuteron in mixture of S and D states using magnetic moment. Range of tensor interaction using quadrupole moment, non-central forces, properties of non-central forces, saturation of nuclear forces: Exchange forces, exchange forces and saturation, isotopic spin formalism.	15
III	**Nucleon-Nucleon Scattering:** n-p scattering at low energies, partial wave analysis, determination of phase shift, scattering of neutron by hydrogen molecules: ortho and para hydrogen, spin dependence of nuclear force, shape independent effective range theory for n-p scattering, determination of scattering length and effective range. Qualitative features of p p scattering, effect of Coulomb and nuclear scattering. High energy n-p and p-p scattering (qualitative). Meson theory of nuclear force: Yukawa and pseudo scalar theory, one pion exchange potential.	15
IV	**Elementary Particles:** Pion-nucleon scattering and its resonance states. Strange particles: Associated Production-strangeness quantum number, Gell–Mann and Nishijima formula, Kaons, lamda, sigma, omega hyperons. Symmetry classification of elementary particles: SU(3)symmetry and eight-fold way, Gell-Mann Okubo formula, Weight diagram, discovery of Ω -particle. **Quark Model:** Fundamental representation of SU(3) and quarks, experimental support for quark model, quark structure of mesons and baryons, color quark and gluons, quark dynamics, charm, beauty and truth quarks, Grand unification theory.	15

Text Books:

1. Introductory Nuclear Physics: Kenneth S. Krane, John Wiley and sons (1988).
2. Subatomic Physics: Nuclei and Particles (Volume II) : Luc Valentin North Holland(1981)
3. Physics of Nuclei and Particles: P. Marmier and E. Sheldon Academic press (1970).
4. Introduction to Particle Physics: M. P. Khanna Prentice Hall of India (1990).
5. Nuclear Physics: R. R. Roy and B.P. Nigam, Wiley Eastern (2014).

Reference Books:

1. Subatomic Physics (Second Edition): Hans Frauenfelder and E. M. Henley, Prentice Hall(1991).
2. Introduction Nuclear Physics : Herald. A. Enge, Addison Wesley (1983).
3. Introductory Nuclear Physics : Samuel S. M. Wong, Prentice – Hall (1996).
4. Atomic Nucleus : R. D. Evans, Tata Mc Graw –Hill (1982).
5. Theoretical Nuclear Physics Volume I : Nuclear Structure: Amosde Shalit and HermanFeshbach, John Wiley (1974).
6. Nuclear and particle Physics : W. Burcham and M. Jobes, Addisionwesley (1998).
7. Theoretical Nuclear Physics : J. M. Blatt and V. F. Weisskoff, Wiley (1962).
8. Introduction to quantum electrodynamics and particle physics: Deep Chadra Joshi,
9. Modern Atomic and Nuclear Physics: A.B. Gupta Books and Allied (2009).
10. Nuclear Physics: S. N. Ghoshal, S Chand & Company (2014).
11. Nuclear Physics: D. C. Tayal, Himalaya Publishing House (5th ed.) (2013).
12. Introduction to Elementary Particles: D. Griffiths, John Wiley (1987).

Formative Assessment for Theory	
Assessment Occasion/ Type	Marks
Internal Assessment Test 1	10
Internal Assessment Test 2	10
Total	20
Formative Assessment as per Guidelines	

Discipline Specific Elective (DSE)

Course Title: Spectroscopy Instrumental Methods
Course Code: A3PHY102AT

Type of Course	Theory/ Practical	Credits	Instruction Hour per Week	Total No. of Lectures/ Hours/ Semester	Duration of Exam in Hours	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSE	Theory	04	04	60	03	20	80	100

Learning Objectives:

1. This Course will introduce to the students widely popular Spectroscopy Instrumental Methods and will empower them to find jobs in testing labs, R & D institutions and research organizations.
2. The Course will cover eight different instrumental methods with techniques of analysis for diverse applications in physical, chemical and life sciences.
3. The eight instrumental methods will teach principles, instrumentation construction, operation and working for handling different samples.
4. The applications will cover sample preparation, measurement and interpretation of atomic and molecular spectra of samples in gaseous, liquid and solid states.
5. The students will learn how to correlate measured spectra to the optical, infrared absorption, emission and scattering properties of samples so as to identify and determine unknown atomic and molecular species both qualitatively and quantitatively.

Course Outcomes:

The specific outcomes of this course are as under:

1. Students will learn the principles of eight analytical techniques for the analysis of atomic and molecular samples.
2. How to select an analytical technique for a given application.
3. How to apply the basic knowledge to characterize atomic & molecular samples.
4. How to acquire the desired knowledge of analytical techniques to work in laboratories of multi-disciplinary subjects.
5. How to cultivate the spirit of entrepreneurship in the field of instrumentation.

Unit	Content	Hours

I	**Components of Optical Instruments:** General designs. Sources of Radiation for UV-Visible and IR regions. Wavelength Selectors (Monochromators): typical prism and grating monochromators. Typical Radiation Transducers used for UV-Visible, Fluorescence, IR and Raman Spectrometry. Principles of FT optical measurements. **Atomic Spectroscopy** **Atomic Absorption Spectrometry**: Optical spectra and factors affecting them. Types of Atomizers. Sample introduction methods and techniques (gases/liquids/solids). Flame and electrothermal atomization methods. Radiation sources: Hollow cathode lamp and Electrodeless discharge lamp. Single- and Double-beam spectrophotometers. Sampling techniques. Simple applications. Atomic Emission Spectrometry: ICP, arc and spark as radiation sources. Sample introduction. Typical IPC spectrometer. Sampling preparation. Applications such as determination of the elements.	**15**
II	**Molecular Spectroscopy** **UV-Visible Absorption Spectrometry**: Beer's law and its limitations. Deuterium/Hydrogen lamps, tungsten filament lamp, LED and Xenon arc lamp. Single- and Double-beam spectrophotometers: construction and working. Sample handling. Characteristic absorptions by organic/inorganic compounds Solvent effects. Detection of functional groups: Bathochromic and Hypsochromic shifts. Applications: qualitative and quantitative analysis of simple spectra. **Fluorescence Spectrometry:** Brief Theory of Fluorescence and Phosphorescence (with energy level diagram), deactivation(radiationless) processes. Transition types associated with quantum efficiency, molecular structure, substituents, temperature and solvent effects. Instruments: Typical Fluorometers and Spectrofluorometers: construction and working. Simple applications.	**15**
III	**Vibrational Spectroscopy** **Infrared Spectrometry:** Molecular vibrations and Group frequencies. IR sources; transducers. Dispersive and FT based spectrometers. Sample handling. Interpretation of the spectra-structure correlations and their application to IR spectra of symmetrical molecules.	

	Raman Spectrometry: Origin of Raman scattering (qualitative) and Raman spectrum. Comparison of vibrational Raman and IR spectra with simple illustrations. Raman sources. Dispersive and FT based Raman spectrometers. Sample handling. Interpretation of the spectra-structure correlations, depolarization ratio and their application to Raman spectra of symmetrical molecules.	**15**
IV	**NMR Spectroscopy** **Proton NMR Spectrometry**: Theory of NMR and its classical description. Resonance condition for the nuclear spin I = ½; the Boltzmann population of energy levels. Relaxation processes: spin-lattice and spin-spin relaxations (qualitative). Types of NMR spectra of simple systems. The chemical shift: Its definition, origin and its correlation with molecular structure. Typical NMR spectrometers (CW/FT). Sample handling. Simple applications of Proton NMR. **Photoelectron Spectroscopy** **Photoelectron spectrometry:** Processes in UPS and XPS. Experimental method for UPS and XPS: sources, electron velocity analyzer and detectors. Ionization processes and Koopmans' theorem. Interpretation of UP spectra of simple atoms and molecules. XP spectra of simple gases with applications.	**15**

Text Books:

1. Instrumental Methods of Analysis: H. H. Willard, L. L. Merrit, J. A. Dean and F. A. Settle, J. K. Jain for CBS Publishers (1986)
2. Principles of Instrumental Analysis (5 th /7 th Ed): D. A. Skoog, F. J. Holler & T. A. Nieman, Harcourt Asia Pvt. Ltd. (1998/2018)
3. Fundamentals of Molecular Spectroscopy: C. N. Banwell and E.M. McCash, Tata McGraw-Hill Co., (4th revd Ed; 9th reprint, 2000).

Reference Books:

1. Raman Spectroscopy: D. A. Long, McGraw Hill Intl. Co. (1977)
2. Modern Spectroscopy (4th Ed): J.M. Hollas, John Wiley & Sons Ltd, UK (2004) [Free soft copy available on Net].

Formative Assessment for Theory	
Assessment Occasion/ Type	Marks
Internal Assessment Test 1	10
Internal Assessment Test 2	10
Total	20
Formative Assessment as per Guidelines	

Discipline Specific Elective (DSE)

Course Title: Magnetism and Dielectrics
Course Code: A3PHY102BT

Type of Course	Theory/ Practical	Credits	Instruction Hour per Week	Total No. of Lectures/ Hours/ Semester	Duration of Exam in Hours	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSE	Theory	04	04	60	03	20	80	100

Learning Objectives:

1. To understand the atomic origin of ferromagnetism and its associated theories.
2. To learn concepts of electron spin resonance and nuclear spin resonance and associated terms.
3. To teach significance of dielectric materials and their internal electric polarizations.
4. To understand the ferroelectric phenomenon, domain structures and their applications.

Course Outcomes:

The specific outcomes of this course are as under:

1. The atomic origin of ferromagnetism and allied phenomena and spin waves can be clear.
2. Helps to understand the electron/nuclear resonances and novel magnetic materials.
3. The importance of dielectric materials and their applications can be realized.
4. Ferroelectric behavior and their related materials can be understood.

Unit	Content	Hours
I	**Ferromagnetism:** Review of Weiss molecular theory of ferromagnetism, its successes and failures under extreme condition of low temperature and critical temperature, physical origin of Weiss molecular field, Heisenberg exchange interaction, exchange integral, exchange energy, the slater's condition for ferromagnetism, spin waves (one dimensional case only), quantization of spin waves and formation of magnons, density of modes, thermal excitation of magnons and Bloch $T^{3/2}$ law, specific heat using spin wave theory. Origin of ferromagnetic domains, hysteresis curve, magnetocrystalline anisotropy energy, Bloch wall formation. **Antiferromagnetism:** Characteristic property of antiferromagnetic substance, Neutron diffraction studies. Two-sub lattice model of molecular field theory of antiferromagnetism, Neel temperature, susceptibility below and above Neel temperature. **Ferrimagnetism:** Ferrimagnetic order, ferrites, Curie temperature and susceptibility of ferrimagnets. Applications of ferrites.	15
II	**Magnetic Resonance:** Basic principles of paramagnetic resonance, spin-spin and	

	spin–lattice relaxation, susceptibility in ac magnetic field power absorption, equations of Bloch, steady state solutions, determination of g factor, line width and spin –lattice relaxation time, electron paramagnetic resonance and nuclear magnetic resonance. **Novel Magnetic Materials and Devices:** Magneto optic effect: Kerr and Faraday. The basic concepts of Giant Magnetoresistance (GMR) and Colossal Magnetoresistance (CMR), applications to memory storage, actuators and sensors.	15
III	**Dielectrics:** Review of basic formulae, dielectric constant and experimental measurement of dielectric constant. Polarizability, local fields, Clausius-Mossotti relation, polarization catastrophe. Sources of polarizability, Dipolar polarizability: dipolar dispersion, Debye's equations, dielectric loss, dipolar polarization in solids, dielectric relaxation. Ionic polarizability. Electronic polarizability: Classical treatment, quantum theory for two level system.	15
IV	**Ferroelectrics:** General properties of ferroelectrics, classification and properties of representative ferroelectric crystals, dipole theory of ferroelectricity, dielectric constant near Curie temperature, microscopic source of ferroelectricity, Lyddane –Sachs Teller relation and its implications, thermodynamics of ferroelectric phase transition, ferrroelectric domains. Ferroelectric domains. Antiferroelectric and ferroelectric phenomena. Pyroelectric and piezoelectric materials and their applications.	15

Text Books:

1. The Physical Principles of Magnetism : A. H. Morrish, John Wiley & sons, New York (1965)
2. Solid State Physics : A. J. Dekker, Macmillan India Ltd., Bangalore (1981)
3. Introduction to Solid State Physics : 5th Edn C. Kittel, Wiley Eastern Ltd., Bangalore (1976)
4. Elementary Solid State Physics : M. A. Omar, Addison Wesley Pvt. Ltd., New Delhi (2000).

5. Elements of Solid State Physics, Second Edition, J.P. Srivastava, Eastern Economy Edition, PHI Learning Private Limited, New Delhi (2009).

Reference Books:

1. Introduction to Magnetic Resonance: A. Carrington and A. D. Mclachlan, Harper & Row, New York, (1967).
2. Elements of Solid State Physics (2nd Ed): J.P. Srivastava, PHI Learning Pvt. Ltd., New Delhi (2009)

Formative Assessment for Theory	
Assessment Occasion/ Type	Marks
Internal Assessment Test 1	10
Internal Assessment Test 2	10
Total	20
Formative Assessment as per Guidelines	

Discipline Specific Elective (DSE)

Course Title: Electronic Instrumentation, Signals and Systems
Course Code: A3PHY102CT

Type of Course	Theory/ Practical	Credits	Instruction Hour per Week	Total No. of Lectures/ Hours/ Semester	Duration of Exam in Hours	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSE	Theory	04	04	60	03	20	80	100

Learning Objectives:

1. Identify and understand transducer-based instruments for measuring physical quantities.
2. Gain knowledge of biomedical signals, medical instrumentation, and signal analysis techniques.
3. Apply mathematical techniques to analyze signals and implement concepts in practical problem-solving.

Course Outcomes:

At the end of this course, the students will be able to-

1. Get a clear picture of various transducer based electronic instruments used for measuring various physical quantities such as light, pressure, temperature, humidity, etc.
2. Obtain a detailed knowledge of role of technology in medicine, biomedical signals and medical instrumentation system such as ECG, EEG, EMG, MRI, etc.
3. Learn classification of signals and systems and various mathematical techniques employed to study and analyze these.
4. A detailed knowledge about conversion of signals from frequency domain to time domain and vice-versa, detailed mathematical background for resolving signals in both domains.
5. Will be able to implement the above practically with the help of Numerical problems solving.

Unit	Content	Hours
I	**Basic Concepts of Measurements & Instruments**: Static characteristics of instruments, accuracy & precision, sensitivity, reproducibility, errors, Transducers, classification & amplification; selection criteria, principles of piezoelectric, photoelectric, thermoelectric transducers, resistance temperature transducers (RTD), thermistor, strain gauge, load cells, LVDT. Digital multimeter, Q meter, Electronic LCR meter.	15
II	**Biomedical Instrumentation:** Role of technology in medicine, Developments in biomedical instrumentation, physiological systems of the body, sources of biomedical signals, basic medical instrumentation system, performance	

	requirements of medical instrumentation systems, intelligent medical instrumentation systems, consumer and portable medical equipment, implantable medical devices, micro-electro mechanical systems (MEMS),wireless connectivity in medical instruments, electrocardiograph (ECG digital stethoscope, electroencephalograph (EEG), electromyography, magnetic resonance imaging (MRI).	15
III	**Continuous Time Signals:** Classification of signals, elementary continuous time signals, elementary discrete time signals, definition of a system, basic operations on signals. Definition of a system, classification of system, examples of systems. Classification of system, even and odd signals, periodic and non-periodic signals, energy and power signals, properties of systems: linearity, time invariance, memory, causality, stability, invertibility. Impulse response representations for LTI systems, convolution, convolution integral and properties, convolution examples, numerical convolutions, system stability. Continuous time systems defined by an input/output differential equation, system modeling, zero input response zero state response and causality. Discrete time systems, difference equation, initial conditions and iterative solution, zero input response.	15
IV	**Transform Domain Representation of Signals:** Fourier series representation for signal classes. Fourier series representation of periodic signals, exponential form of the Fourier series, a periodic signal representation, Fourier transform of non-periodic signals, transforms of some useful functions, properties, generalized Fourier transform. Fourier transform of continuous-time signals, non-periodic examples. Computations of output response via the Fourier transform, analysis of ideal filters. Discrete time Fourier transform of periodic signals, difference between Fourier series and Fourier transform, system analysis via the DTFT and DFT.	15

Text Books:

1. Electronic Measurements and Measuring techniques: A. D. Helfrick and W.D. Cooper
2. Electrical and Electronic measurements and techniques: A. K. Shawney The educational and Technical Publications, New Delhi (1985)

3. Biomedical digital signal procession: William J. Tompkins, Prentice hall of India Pvt. Ltd. (2000)
4. Electronic Signals and Systems: Paul A. Lynn, English Language Book Society Macmillan (1986)

Reference Books:

1. Communication systems: Simon Haykin, Wiley eastern Ltd. New Delhi (1983)
2. Modern Communication Systems – Principles and Applications: Leon W. Couch II, Prentice Hall of India Pvt. Ltd., New Delhi (1998)
3. Discrete time Signal procession –2nd Edition, A.V. Oppenhiem, R. W. Schafer and J. R. Buck, Prentice Hall, New Jersey (1999).
4. Digital Signal Processing – A Computer Based approach: Sajith K. Mitra, Tata – McGraw Hill Publications, New Delhi (2000).
5. Principles of Electronic Instrumentation: A. J. Diefenderfer, and B.E. Hotton, Saunders college Publishing, London (1994).

Formative Assessment for Theory	
Assessment Occasion/ Type	Marks
Internal Assessment Test 1	10
Internal Assessment Test 2	10
Total	20
Formative Assessment as per Guidelines	

Discipline Specific Elective (DSE)

Course Title: Nuclear Detectors, Accelerators and Neutron Physics
Course Code: A3PHY102DT

Type of Course	Theory/ Practical	Credits	Instruction Hour per Week	Total No. of Lectures/ Hours/ Semester	Duration of Exam in Hours	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSE	Theory	04	04	60	03	20	80	100

Learning Objectives:

1. To review and discuss the basic and advanced nuclear detectors.
2. To introduce nuclear electronics involved in nuclear devices.
3. To familiarize particle accelerators, ion sources and applications.
4. To provide knowledge to pursue research in advanced nuclear spectroscopy techniques
5. To teach the properties of neutrons, their production and detection.

Course Outcomes:

After completing this course, the students should be able to

1. Learn about the classification, mechanisms, properties and factors affecting performance of scintillator detectors and nuclear electronics.
2. Learn about the differences between single channel analyzer and multichannel analyzer in NaI(TI) gamma ray spectrometers and to estimate calibration constant.
3. Know the basics, construction, working, advantages and disadvantages of semiconductor detectors and types and characteristics of solid-state detectors.
4. Understand about the various types of nuclear accelerators and their basic components and types of accelerations and principles of operation.
5. Understand the basic principles, construction and working of energy and wavelength dispersive X-ray fluorescence spectrometers.
6. Learn the basics and working principles of positron annihilation spectroscopy and perturbed angular correlation for study of condensed matter.
7. Learn about the neutron classification, sources of neutrons and neutron detectors, especially BF_3 counter and ^3He based neutron detector.

Unit	Content	Hours
I	**Nuclear Detectors:** Basic physical processes in radiation detection. Scintillation detectors: scintillation mechanism and classification of scintillation materials, photomultiplier tubes; gain and types of photomultiplier tubes. Preamplifiers: charge sensitive, voltage sensitive and current sensitive preamplifiers, pulse shaping, pulse stretching. Amplifiers: linear and spectroscopy amplifiers. Single channel analyzers: integral, window and normal modes. Multichannel analyzer: various types of ADC, memory, linear gate and working, Factors affecting the performance of the scintillation detectors. Some commonly used detectors and	

	detector systems. NaI(TI) gamma ray spectrometer; calibration, detection efficiency, energy resolution, escaping radiation and resulting peaks in scintillation pulse amplitude spectrum, photo peak, Compton edge and back scattered peak, single escape and double escape peak. Role of thickness of the inorganic crystal NaI(Tl) for detecting the radiation. **Semiconductor Detector:** Physics of semiconductor detectors, detector medium requirement and role of p-n junction, Lithium drifted germanium detector, high purity germanium detector, Lithium drifted silicon detector, position sensitive detector, compound semiconductor detectors.	15
II	**Particle Accelerators:** Basic components of accelerator, types of accelerations, principles of operation. **Ion Sources:** Duoplasmatron ion source and electron cyclotron resonance (ECR) ion source. **Accelerators:** Principle and working of electrostatic accelerators, cyclotron accelerators, synchrotrons, Linear accelerators. **Application of ion beams:** Rutherford Backscattering Spectroscopy (RBS), Elastic Recoil Detection (ERD), Nuclear Reaction Analysis (NRA).	15
III	**X-ray Fluorescence Spectroscopy:** Continuum and Characteristic X-rays; X-ray Fluorescence; Energy and Wavelength Dispersive X-ray Fluorescence Spectrometers; Primary, Secondary and Tertiary Fluorescence, Micro-XRF, Total XRF and their applications **Positron Annihilation Spectroscopy:** Principles, positron sources and experimental arrangements; Angular Correlation of Annihilation Radiation (ACAR); Doppler Broadening of Annihilation Radiation (DBAR); Positron Annihilation Life Time (PALT) measurements, applications. **Perturbed Angular Correlation (PAC):** PAC sources, experimental arrangement, magnetic dipole interaction, electric quadruple interaction, and applications.	15
IV	**Neutron Physics:** Basic properties of neutron, production of neutrons, detection	

	of slow and fast neutrons; BF_3 counter and ^3He based neutron detector, scintillation detectors for fast neutrons, detection of ultra-high energy neutrons, cloud chamber as a neutron detector, the crystal monochromator, neutron diffraction (theory), powder and single crystal neutron diffraction, neutron diffraction from magnetic materials, neutron diffraction in fluids, reflection of neutrons, polarization of neutrons, small angle neutron scattering (SANS).	15

Text Books:

1. Atomic and Nuclear Physics Volume II: S. N. Goshal, S. Chand and company (1998)
2. Nuclear Radiation Detectors: S. S. Kapoor and V. S. Ramamurthy, Wiley Eastern Limited (1986).
3. Techniques for Nuclear and Particle: W. R. Leo, Springer Verlag (1987).
4. Radiation Detection and Measurement: Glenn. F. Knoll, John Wiley and sons (1989).
5. Principles of Charged Particle Acceleration: S. Humphris, John Wiley (1986).
6. Introduction to Neutron Physics: L. F. Curtis, East west press (1958).
7. Nuclear Electronics: P.W. Nicholson, John Wiley & Sons (1974).
8. Experimental neutron scattering: B.T.M. Willis & C.J. Carlie, Oxford University Press (2009).
9. Introduction to Neutron Physics: L.F. Curtiss, East West Press (1969).

Reference Books:

1. Introduction to Nuclear Physics: Herald A. Enge, Addison – Wesley (1983)
2. Physics of Nuclei and Particles Vol II: P. Marmier and E. Sheldon, Academic Press (1969)
3. Nuclei and Particles (second edition): E. Segre, Benjamin (1977)
4. Nuclear and Particle Physics: W. Burcham and M. jaobes, Addison Wesley (1998)
5. Physics of Nuclei and Particles: P. Marmier and E. Sheldon Academic press (1970)
6. Alpha, Beta and Gamma Spectroscopy: K Seighban Vol. I and II North Holland (1966)
7. Experimental Techniques in Nuclear Physics: Dorin N. Poenaru, Walter Greiner Walter de Gruyter, Berlin(1997)

8. Experimental Neutron Scattering: BTM Willis and C J Calile Oxford University Press (2009)
9. Quantitative X ray Fluorescence analysis: G. R. Lachance and F. Claisse John Wiley and sons (1995)
10. Ion Implantation Science and Technology: J. P. Ziegler, Academic Press (1988).
11. Nuclear electronics: Kowalski E., Springer Verlag, Berlin (1970)
12. Nuclear Physics Experimental and theoretical, Hans H.S., New Age International Publishers (2001).

Formative Assessment for Theory	
Assessment Occasion/ Type	Marks
Internal Assessment Test 1	10
Internal Assessment Test 2	10
Total	20
Formative Assessment as per Guidelines	

Open Elective Course (OEC)

Course Title: Open Elective Course – II: A) Instrumental Methods
Course Code: A3PHY202T

Type of Course	Theory/ Practical	Credits	Instruction Hour per Week	Total No. of Lectures/ Hours/ Semester	Duration of Exam in Hours	Formative Assessment Marks	Summative Assessment Marks	Total Marks
OEC	Theory	04	04	60	03	20	80	100

Learning Objectives:

1. To teach the general concepts around experimental measurements of physical parameters.
2. To understand the importance of optical spectroscopy with respect to various techniques.
3. To give the importance of fluorescence and nuclear parameters measurements.
4. To teach the mechanisms of radioactive decay of elements and their applications.

Course Outcomes:

At the end of this course, the students will be able to

1. Understand the basic principles of working of Digital voltmeter, electronic multimeter, digital multimeter, power meter, electronic LCR meter and cathode ray oscilloscope.
2. Learn about UV/Visible absorption spectrometry and gain knowledge of about Single/double beam spectrometer. Infrared absorption spectroscopy, sample techniques etc.
3. Understand the basic principles of Fluorescence and Phosphorescence, energy level diagram, Fluorimeter construction, working its applications.
4. Learn about radioactivity and its applications as well as nuclear Physics applications.

Unit	Content	Hours
I	**Electronic Instruments for Measurement**: Single and dual power supply units. Digital voltmeter principles of electronic multimeter, digital multimeter, Q meter, Power meter, Electronic LCR meter, Frequency & time interval counters. Electronic instruments for signal generation & analysis – Function generators, Pulse generators, Frequency synthesizer, Principles & applications of cathode ray oscilloscope.	15
II	**UV/Visible Absorption Spectrometry:** Concept of electronic energy levels, transitions, Beer's law and its limitations. Instrumentation: Components of Colorimeter, Single beam spectrometer, Double beam spectrophotometer; principle, construction and working, sampling technique; Applications. **Infrared Absorption Spectrometry:** Concept of molecular vibrational energy levels, transitions. Instrumentation: Components of single beam and double beam spectrometers; principle, construction, working, sampling technique;	

	Applications	15
III	**Fluorescence Spectrometry:** Fluorescence and Phosphorescence phenomena (with energy level diagram). quantum yield, fluorescence quenching, rate parameters, radiative and natural lifetime. Fluorimeter: Basic components, principle, construction, working, sampling technique; Applications. **Nuclear Magnetic Resonance Spectrometry:** Principle of resonance; the chemical shift. Components of NMR spectrometer: principle, construction, working, sampling technique; Applications.	15
IV	**Radioactivity and its Applications** **Radioactivity:** Unit of radioactivity, source strength, production and decay of radioactivity, alpha decay, beta decay, gamma decay, natural and artificial radioactivity, Geiger counter, NaI(Tl) detector. **Applications of Nuclear Physics:** Trace element analysis, mass spectrometry with accelerators. Alpha decay application, diagnostic nuclear medicine, therapeutic nuclear medicine, food preservation, plant metabolism.	15

Text Books

1. Cooper W. Electronic Instrumentation & Measurement Technique – Prentice Hall of India.
2. George C. Barney, Intelligent Instrumentation – Prentice Hall India
3. Instrumental Methods of Analysis : H. H. Willard, L. L. Merrit, J. A. Dean and F. A. Settle, J. K. Jain for CBS Publishers (1986)
4. Principles of Instrumental Analysis (5th ed) : D. A. Skoog, F. J. Holler & T. A. Nieman, Harcourt Asia Pte. Ltd. (1998)
5. Fundamentals of Molecular Spectroscopy : C. N. Banwell and E.M. McCash, Tata Mc Graw Hill Co., 4th revised edition, (9th reprint, 2000).
6. Introductory Nuclear Physics: Kenneth s Krane, John Wiley and Sons (2005).

Formative Assessment for Theory	
Assessment Occasion/ Type	Marks
Internal Assessment Test 1	10
Internal Assessment Test 2	10
Total	20
Formative Assessment as per Guidelines	

Open Elective Course (OEC)

Course Title: Open Elective Course – II: B) Physics of Nanomaterials
Course Code: A3PHY202T

Type of Course	Theory/ Practical	Credits	Instruction Hour per Week	Total No. of Lectures/ Hours/ Semester	Duration of Exam in Hours	Formative Assessment Marks	Summative Assessment Marks	Total Marks
OEC	Theory	04	04	60	03	20	80	100

Learning Objectives:

1. To understand the importance of nanoscience and its basic Physics.
2. To get an idea of various methods of syntheses that is adopted for nanomaterials.
3. To understand the various physical and chemical method characterization of nanomaterials.
4. To give a glimpse of general properties of nanomaterials in comparison to their bulk counterparts.

Course Outcomes:

The specific outcomes of this course are as under:

1. The course offers a good understanding on the basics of nanoscience.
2. The course offers a good understanding basic quantum Mechanics.

3. It also helps to synthesis and characterization of nano-materials using SEM, TEM, STEM, AFM and Diffraction techniques.
4. Learn about properties of nano-materials like electrical mechanical, band structures etc.

Unit	Content	Hours
I	**Basics of Nanoscience:** The nanoscale, historical background, quantum confinement, size dependent properties, types of nanomaterials, fullerenes, nanowires, nanotubes, thin film. **Basic Quantum Mechanics:** Wave particle duality, Heisenberg uncertainty principle Schrödinger equation solution of one dimensional time independent equation, particle in a one dimensional box; density of states for zero , one , two and three dimensional box; particle in a coulomb potential. Tunneling of a particle through potential barrier	15
II	**Synthesis of Nanomaterials:** Physical methods mechanical ball milling, melt mixing; evaporation ion sputtering, laser ablation, laser pyrolysis, chemical vapour deposition, molecular beam epitaxy. **Chemical Methods:** colloidal synthesis and capping of nanoparticles. Types of nanoparticles metals, semiconductors, graphene, carbon nano tubes etc.	15
III	**Characterization Techniques:** microscopes optical, SEM, TEM, STM, AFM; diffraction techniques XRD, EXAFS neutron diffraction; spectroscopes UV visible IR absorption, FTIR, Photoluminescence.	15
IV	**Properties of Nanomaterials:** Mechanical; Electrical classification metals semi conductors, insulators, band structures; mobility, resistivity, Hall effect, magneto resistance; Optical absorption and transmission, photoluminescence, electro luminescence, thermoluminescence; Magnetic magnetism and types of magnetic materials dia, para, ferro, antiferro; nano magnetism.	15

Text Books:

1. Nanotechnology: Principles and practices, S. K Kulkarni, Capital Publ. Co., New Delhi (2007)
2. Nanocrystals: Synthesis, Properties and Applications, C.N.R. Rao, P. John Thomas and G.U. Kulkarni, Springer series in Materials Science 95, Springer Verlag, Berlin, Heidelburg (2007).

Reference Books:

1. Quantum Mechanics Volume 1: Basic Concepts, Tools and Applications, C. Cohen-Tannoudji, B. Diu and Franck Laloe, WILEY-VCH, Boschstr Germany (2020)
2. Quantum Mechanics Volume 2: Angular Momentum, Spin, and Approximation Methods, C. Cohen-Tannoudji, B. Diu and Franck Laloe, WILEY-VCH, Boschstr Germany (2020)
3. The Physics and Chemistry of Solids, Stephen Elliott, Wiley (1998)
4. Solid State Physics, A.J. Dekker, Macmillan India Ltd., Bangalore (2000).
5. Introduction to Nanotechnology, Charles P. Poole Jr., Frank J. Owens, Wiley (2003)
6. Electronic Transport in Mesoscopic Systems, SupriyoDatta, Cambridge University Press, United Kingdom (1997)
7. Nanotubes and Nanowires, C.N.R Rao, A Govindaraj, Leela Srinivas Panchakarla, Nanoscience & Nanotechnology, RSC Publications (2021)
8. Quantum Transport: From Atoms to Transistors, SupriyoDatta, Cambridge University Press, United Kingdom (2005)
9. Encyclopedia of Nanoscience and Nanotechnology, Hari Singh Nalwa, American Scientific Publishers, USA(2019)

Formative Assessment for Theory	
Assessment Occasion/ Type	Marks
Internal Assessment Test 1	10
Internal Assessment Test 2	10
Total	20
Formative Assessment as per Guidelines	

Discipline Specific Elective (DSE)

Course Title: Atomic and Molecular Physics Practical – I
Course Code: A3PHY103AP

Type of Course	Theory/ Practical	Credits	Instruction Hour per Week	Total No. of Lectures/ Hours/ Semester	Duration of Exam in Hours	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSE	Practical	04	08	120	04	20	80	100

Learning Objectives:

To make students to

1. Understand the atomic and molecular phenomena through the analysis of wavelength data.
2. Understand the theoretical models of molecules.
3. Extended analysis by way of physical experiments.

Course Outcomes:

After completion of this course the students would

1. Learn analysis of given wavelength data of atomic & molecular phenomena by applying theoretical principles learnt by them.
2. Learn how to validate theoretical models by analyzing given empirical data
3. Learn advanced level of analysis by taking measurements from physical experiments.

Experiments:

1. Study of Constant Deviation Spectrograph
2. Vibrational analysis of CN violet bands.
3. Spectrochemical analysis of Mixture.
4. Determination of the electronic charge by Millikan's oil drop experimental method.
5. Vibrational analysis of AlO band system measured on the miniature USB spectrometer

6. Analysis of Rotational Raman spectral analysis of N_2 molecule.

(New experiments/assignment may be added by the Dept. of Physics, KUD)

Reference Books:

1. Experimental Spectroscopy (3rd Edition): R. A. Sawyer. Dover Publication, Inc, New York (1963).
2. Atomic Spectra and Atomic Structure (2nd Edition) – G. Herzberg. Dover Publication New York (1944)
3. Atomic Spectra – H.E. White, Mc Graw –Hill, New York (1934).
4. Lab. Manuals.
5. Molecular Spectra & Molecular Structure Vol. I: G. Herzberg, D. Van Nostrand Co,New York (1950)
6. Instrumental Methods of Analysis: H. H. Willard, L. L. Merrit, J. A. Dean and F. A.Settle, J. K. Jain for CBS Publishers (1986)
7. The Identification of Molecular Spectra: R.W. B. Pears &A. G. Gaydon, Wiley, New York (1961).

(New experiments/assignment may be added by the Dept. of Physics, KUD)

Formative Assessment for Theory	
Assessment Occasion/ Type	Marks
Internal Assessment Test 1	20
Total	20
Formative Assessment as per Guidelines	

Discipline Specific Elective (DSE)

Course Title: Condensed Matter Physics Practical – I
Course Code: A3PHY103BP

Type of Course	Theory/ Practical	Credits	Instruction Hour per Week	Total No. of Lectures/ Hours/ Semester	Duration of Exam in Hours	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSE	Practical	04	08	120	04	20	80	100

Learning Objectives:

1. Understand the general theory of X-ray diffraction.
2. To learn indexing of X-ray patterns recorded for different crystal structures.
3. Learning of significance X-ray scattering intensity and its calculation to solve the structure.
4. Learning of computer programming to calculate the lattice parameters.

Course Outcomes:

The specific outcomes of this course are as under:

1. Calculation of d-spacing, structure factor and indexing of cubic and non-cubic pattern can be understood.
2. The significance of intensity of X-ray scattering and its relation to the position of atoms in a unit cell can be learnt.
3. The experimental measurement of specific heat of different metals can be realized.

Experiments:

1. Structure factor calculations
2. d spacing calculations
3. Indexing of cubic systems
4. Determination of Debye temperature by study of specific heat of metals
5. Assignment using FORTRAN programming
6. Calculation of relative integrated intensity
7. Indexing of tetragonal systems
8. Obtaining X ray pattern for a given substance using X ray diffractometer and indexing the pattern.

(New experiments/assignment may be added by the Dept. of Physics, KUD)

Reference Books

1. X ray diffraction: B.D. Cullity, Addison Wesley, New York (1972).
2. X ray diffraction procedures: H.P. Klug and L.E. Alexander, John Wiley and sons, New York.
3. Interpretation of X ray powder diffraction pattern: H.P. Lipson and H. Steeple, Macmillan, London (1968).
4. Introduction to Solid State Physics: 5th Ed. C. Kittel, Wiley Eastern Ltd., Bangalore (1976)
5. Elementary Solid StatePhysics: M. A. Omar, Addison Wesley Pvt. Ltd., New Delhi (2000)
6. Introduction to magnetochemistry: A. Earnshaw, Academic press, London (1968).
7. Lab manuals.

Formative Assessment for Theory	
Assessment Occasion/ Type	Marks
Internal Assessment Test 1	20
Total	20
Formative Assessment as per Guidelines	

Discipline Specific Elective (DSE)

Course Title: Electronics and Communication Practical – I
Course Code: A3PHY103CP

Type of Course	Theory/ Practical	Credits	Instruction Hour per Week	Total No. of Lectures/ Hours/ Semester	Duration of Exam in Hours	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSE	Practical	04	08	120	04	20	80	100

Learning Objectives:

1. Understand amplitude, frequency, and pulse modulation techniques in electronic communication.
2. Learn digital communication fundamentals, including intersymbol interference and pulse shaping.
3. Apply modulation and communication concepts to practical problems and numerical analysis.

Course Outcomes:

Upon completion of this course, the students will be able to-

1. Design and learn implementing the operational amplifier IC 741 based wave form generator circuits
2. Design and learn implementing op-amp 741 based instrumentation amplifier and characterize it
3. Design and learn implementing op-amp based twin-T and notch filter circuits.
4. Implementation of 2's complement adder and subtractor and bidirectional shift registers

Experiments:

1. Square, triangular and ramp generation using op amp
2. Instrumentation amplifier gain, CMRR and input impedance
3. Precision half wave and full wave rectifier using Op amp
4. Astable or free running multivibrator
5. Design the regulated power supply using voltage IC regulators
6. 2's complement adder and subtractor

(New experiments/assignments may be added)

Reference Books:

1. Operational Amplifier and Linear IC: Robert F. Coughlin and Frederick F. Driscoll, PHI publications (1994).
2. Op Amps and linear Integrated Circuits: R Gayakwad, PHI publications, New Delhi (2000).
3. Digital Principles and Applications: A.P. Malvino and D. Leach, TMH Publications (1991).
4. Digital fundamentals – 8th edition: Thomas L Floyd, Pearson Education (2003)
5. Microelectronics Circuits: Adel S. Sedra and Kenneth C. Smith, Oxford University Press (1991).
6. Digital Computer fundamentals, Thomas C. Bartee, McGraw Hill Ltd. (1977).
7. Digital Logic and Computer Design: Morris Mano. Prentice Hall of India Pvt. Ltd New Delhi (2000).
8. Logic Circuit Design: Alan W. Shaw, Sanders College Publication Company (1999).

(New experiments/assignment may be added by the Dept. of Physics, KUD)

Formative Assessment for Theory	
Assessment Occasion/ Type	Marks
Internal Assessment Test 1	20
Total	20
Formative Assessment as per Guidelines	

Discipline Specific Elective (DSE)

Course Title: Nuclear and Particle Physics Practical – I
Course Code: A3PHY103DP

Type of Course	Theory/ Practical	Credits	Instruction Hour per Week	Total No. of Lectures/ Hours/ Semester	Duration of Exam in Hours	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSE	Practical	04	08	120	04	20	80	100

Learning Objectives:

1. To understand the performance of NaI (Tl) scintillation detector and its efficiency
2. To know the electronic part of the detecting system for the nuclear radiation using different circuits
3. Understanding the performance of regulated power supply
4. Understanding the pulse generator using IC and transistor

Course Outcomes:

After successful completion of this course, the students will be able to

1. Acquire practical knowledge on calibrating NaI(Tl)gamma ray spectrometer and to determine the energy of a given gamma ray source and resolution of the detector for the various energies.
2. Learn various modes in a multichannel analyzer and use them to calculate the energy resolution, energy of gamma ray.
3. Able to verify the Bohr's frequency condition and Moseley's law using MCA based NaI(Tl) scintillation detector.
4. Learn to construct and design the multi vibrator circuit using transistors and IC 555, pulse generator circuit using IC 4049 and study its output waveforms.
5. Learn the rotational energy and angular momentum of a compound nucleus.

Experiments:

1. Calibration of NaI(Tl) scintillation spectrometer using different radioactive sources
2. Attenuation beta particles I
3. Verification of Mosley's law

4. Positron annihilation
5. Multvibrator circuit using transistors and IC 555
6. Pulse generator using IC 4049
7. Attenuation gamma rays I
8. Magnetic beta ray spectrometer I
9. Nuclear rotational studies of nuclear reactions
10. Regulated power supply using transistors and LM 309
11. R.C coupled amplifier
12. Study and performance of IC 555
13. Coincidence circuit

(New experiments/assignment may be added by the Dept. of Physics, KUD)

Reference Books

1. Experiments in Modern Physics: A. C. Melissions, Academic Press (NY) (1966)
2. Experiments in Nuclear Science, ORTEC Application Note. ORTEC, (1971) (Available in Nuclear Physics Laboratory)
3. Practical Nucleonics: F. J. Pearson., and R. R.Osborne, E & F. N. Spon Ltd. London (1960)
4. The Atomic Nucleus: R. D. Evans, Tata Mc Graw Hill Pub. Comp. Ltd. (1960)
5. Nuclear Radiation DetePG85T 303N Nuclear Detectors, Accelerators and Neutron Physicists: S. S. Kapoor and V. S. Ramamurthy, Wiely Eastern Limited (1986)
6. Experimental Nucleonics: E. Bleuler and G. J. Goldsmith, Rinehart & Co. Inc. (NY) (1958)
7. A manual of experiments in reactor physics: Frank A. Valente, Macmillan company (1963)
8. A practical introduction to electronic circuits: Martin Harthley Jones, Cambridge University Press (1977)
9. Integrated circuit projects: R. M. Marston, Newnes Technical Books (1978)
10. Semiconductor projects: R. M. Marston, A Newnes Technical Books (1978)
11. Waveform generator projects: R. P. Marston, A Newnes Technical Books (1978)

Formative Assessment for Theory	
Assessment Occasion/ Type	Marks
Internal Assessment Test 1	20
Total	20
Formative Assessment as per Guidelines	

Discipline Specific Elective (DSE)

Course Title: Atomic and Molecular Physics Practical – II
Course Code: A3PHY104AP

Type of Course	Theory/ Practical	Credits	Instruction Hour per Week	Total No. of Lectures/ Hours/ Semester	Duration of Exam in Hours	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSE	Practical	04	08	120	04	20	80	100

Learning Objectives:

The objective of this course is to make the students

1. Learn analysis of atomic & molecular phenomena.
2. Learn the determination of the screening constants for sodium doublets
3. Understand the analysis of the data of Zeeman effect experiment
4. Understand Lande's interval rule and its verification for a given multiplet spectra.
5. Understand the concepts in quantum mechanics.

Course Outcomes:

After successful completion of this course, the students will be able to

1. Learn analysis of given wavelength data atomic & molecular phenomena obtained through spectrographs

2. Determine the screening constants for sodium doublets
3. Analyze the data of Zeeman effect experiment and determine the e/m ratio of electron.
4. Verify Lande's interval rule for a given multiplet spectra.
5. Do quantum mechanical calculations of the given assignment.

Experiments:

1. Study of Grating spectrograph
2. Study of Small Quartz Spectrograph
3. Determination of the screening constants for sodium doublets.
4. Study of Zeeman Effect: Determination of e/m for an electron.
5. Verification of Lande's interval rule.
6. Quantum mechanical assignments.

(New experiments/assignment may be added by the Dept. of Physics, KUD)

Reference Books:

1. Experimental Spectroscopy (3rd Edition): R. A. Sawyer. Dover Publication, Inc, New York (1963).
2. Atomic Spectra and Atomic Structure (2nd Edition) – G. Herzberg. Dover Publication New York (1944)
3. Atomic Spectra – H.E. White, Mc Graw –Hill, New York (1934).
4. Lab. Manuals.
5. Molecular Spectra & Molecular Structure Vol. I : G. Herzberg, D. Van Nastr and Co, New York (1950)
6. Instrumental Methods of Analysis: H. H. Willard, L. L. Merrit, J. A. Dean and F. A. Settle, J. K. Jain for CBS Publishers (1986)
7. The Identification of Molecular Spectra: R.W. B. Pears & A. G. Gaydon, Wiley, New York (1961).
8. Applied Quantum Mechanics by A.F.J. Levi, Cambridge University Press, 2003

Formative Assessment for Theory	
Assessment Occasion/ Type	Marks

Internal Assessment Test 1	20
Total	20
Formative Assessment as per Guidelines	

Discipline Specific Elective (DSE)

Course Title: Condensed Matter Physics Practical – II
Course Code: A3PHY104BP

Type of Course	Theory/ Practical	Credits	Instruction Hour per Week	Total No. of Lectures/ Hours/ Semester	Duration of Exam in Hours	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSE	Practical	04	08	120	04	20	80	100

Learning Objectives:

1. Understanding of conducting various experiments that are important to estimate the materials parameters.
2. Leaning of measurements of basic parameters materials.
3. Conducting the Hall Effect to identify type of charge carriers and their concentration.
4. Determination of magnetic susceptibility, dielectric constant and other physical parameters.

Course Outcomes:

The specific outcomes of this course are as under:

1. It helps to experimentally measure the ratio of fundamental constants like e and k_B.
2. The magneto-resistance effect in a semiconductor can be determined.
3. The ferromagnetic to paramagnetic phase transition in a metallic sample can be carried out.
4. The experimental determination of electrical resistivity of semiconductor by four probe method can be understood

Experiments:

1. Hall effect and Hall mobility.
2. Determination of e/k_B.
3. Susceptibility of paramagnetic substance by Gouy's method.
4. Specific heat of metals.
5. Magnetoresistance of semiconductors.
6. Determination of Curie temperature of a ferromagnet.
7. Electron spin resonance.
8. Resistivity by four probe method.
9. Determination of elastic constants.
10. Thermoluminescence studies of alkali halides by X ray irradiations.
11. Size estimation of nanocrystals.

(New experiments/assignment may be added by the Dept. of Physics, KUD)

Reference Books:

1. X ray diffraction: B.D. Cullity, Addison Wesley, New York (1972).
2. X ray diffraction procedures: H.P. Klug and L.E. Alexander, John Wiley and sons, New York.
3. Interpretation of X ray powder diffraction pattern: H.P. Lipson and H. Steeple, Macmillan, London (1968).
4. Introduction to Solid State Physics : 5th Edn C. Kittel, Wiley Eastern Ltd., Bangalore (1976)
5. Elementary Solid State Physics : M. A. Omar, Addison Wesley Pvt. Ltd., New Delhi (2000)
6. Introduction to magnetochemistry: A. Earnshaw, Academic press, London (1968).
7. Lab manuals

Formative Assessment for Theory	
Assessment Occasion/ Type	Marks
Internal Assessment Test 1	20
Total	20
Formative Assessment as per Guidelines	

Discipline Specific Elective (DSE)

Course Title: Electronics and Communication Practical –II
Course Code: A3PHY104CP

Type of Course	Theory/ Practical	Credits	Instruction Hour per Week	Total No. of Lectures/ Hours/ Semester	Duration of Exam in Hours	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSE	Practical	04	08	120	04	20	80	100

Learning Objectives:

1. Implement crystal oscillators, frequency dividers, and counters with displays.
2. Conduct analog and digital experiments using optical fibers.
3. Analyze phase-locked loop ICs and understand counter principles.

Course Outcomes:

Upon completion of this course, the students will be able to-

1. Implement Use of crystal oscillator and frequency division circuits.
2. Conduct Analog and digital optical fiber experiments .
3. Study of staircase generator using 4-bit counters and decade counter with 7-segment display.
4. Study Phase locked loop ICs and characteristics.

Experiments:

1. Optical fiber experiments: Analog & digital.
2. Phase locked loop ICs and characteristics.
3. Staircase generator using 4-bit counters.
4. Study PWM using digital optical fiber kit.

5. 8-bit synchronous and asynchronous counters.
6. Decade counter with 7-segment display.

(New experiments/assignment may be added by the Dept. of Physics, KUD)

Reference Books:

1. Operational Amplifier and Linear IC & Robert F. Coughlin and Frederick F. Driscoll, PHI publications (1994).
2. Op Amps and linear Integrated Circuits: R Gayakwad, PHI publications, New Delhi (2000).
3. Digital Principles and Applications: A.P. Malvino and D. Leach, TMH Publications (1991).
4. Digital fundamentals – 8th edition: Thomas L Floyd, Pearson Education (2003)
5. Microelectronics Circuits: Adel S. Sedra and Kenneth C. Smith, Oxford University Press (1991).
6. Digital Computer fundamentals, Thomas C. Bartee, McGraw Hill Ltd. (1977).
7. Digital Logic and Computer Design: Morris Mano. Prentice Hall of India Pvt.Ltd New Delhi (2000).
8. Logic Circuit Design: Alan W. Shaw, Sanders College Publication Company (1999).

Formative Assessment for Theory	
Assessment Occasion/ Type	Marks
Internal Assessment Test 1	20
Total	20
Formative Assessment as per Guidelines	

Discipline Specific Elective (DSE)

Course Title: Nuclear and Particle Physics Practical –II
Course Code: A3PHY104DP

Type of Course	Theory/ Practical	Credits	Instruction Hour per Week	Total No. of Lectures/ Hours/ Semester	Duration of Exam in Hours	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSE	Practical	04	08	120	04	20	80	100

Learning objectives:

1. To study the nuclear phenomenon using the detectors
2. Understanding the differences in the calibration parameter and differences in the detecting system
3. Understanding the mode of operation in counting system using single channel analyser and multi-channel analyser.
4. Understanding the interaction of radiation with matter.

Course Outcomes:

After successful completion of this course, the students will be able to

1. Determine the half-life of ^{116}In nucleus by observing the beta activity with time using G.M. Counting System
2. Determine the end point energy of beta particles from ^{204}Tl source using Nomogram method using G. M. Counting System.
3. Estimate the K x-ray fluorescence yield and K x-ray production cross section in silver target using ^{57}Co source using MCA based NaI(Tl) scintillation spectrometer.
4. Design and construct linear pulse amplifier using BC 107 and AC 128 transistors and to study its performance, output pulse height is linearly proportional to input pulse height.
5. Determine the rest mass energy of electron using NaI(Tl) gamma ray spectrometer using different gamma sources (^{137}Cs, ^{60}Co, ^{54}Mn).

Experiments:

1. Attenuation beta particles II
2. Half-life of Indium
3. Attenuation gamma rays II

4. Compton Scattering
5. Study of emitter follower circuit
6. FET amplifier
7. Magnetic beta ray spectrometer I I
8. X ray fluorescence studies
9. Rutherford scattering
10. Pulse stretcher and pulse delay using IC 74121
11. Pulser: variable width and frequency using LM 310
12. Scale of two circuit using IC and transistors

(New experiments/assignment may be added by the Dept. of Physics, KUD)

Reference Books

1. Experiments in Modern Physics : A. C. Melissions, Academic Press (NY) (1966).
2. Experiments in Nuclear Science, ORTEC Application Note. ORTEC, (1971).
3. (Available in Nuclear Physics Laboratory).
4. Practical Nucleonics: F. J. Pearson., and R. R.Osborne, E & F. N. Spon Ltd. London (1960).
5. The Atomic Nucleus: R. D. Evans, Tata Mc Graw Hill Pub. Comp. Ltd. (1960).
6. Nuclear Radiation Detectors : S. S. Kapoor and V. S. Ramamurthy, Wiely Eastern Limited (1986).
7. Experimental Nucleonics : E. Bleuler and G. J. Goldsmith, Rinehart & Co. Inc. (NY) (1958).
8. A manual of experiments in reactor physics : Frank A. Valente, Macmillan company (1963).
9. A practical introduction to electronic circuits : Martin Harthley Jones, Cambridge University Press (1977).
10. Integrated circuit projects : R. M. Marston, Newnes Technical Books (1978).
11. Semiconductor projects : R. M. Marston, A Newnes Technical Books (1978).
12. Waveform generator projects : R. P. Marston, A Newnes Technical Books (1978).

Formative Assessment for Theory	
Assessment Occasion/ Type	Marks
Internal Assessment Test 1	20
Total	20
Formative Assessment as per Guidelines	

M.Sc. SEMESTER – IV

Discipline Specific Course (DSC)

Course Title: Classical Electrodynamics
Course Code: A4PHY013T

Type of Course	Theory/ Practical	Credits	Instruction Hour per Week	Total No. of Lectures/ Hours/ Semester	Duration of Exam in Hours	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	Theory	04	04	60	03	20	80	100

Learning Objectives:

1. To understand the basic mathematical formulation of electrostatics.
2. To learn about the dynamics of magnetostatics under different, conditions.
3. To learn about electrodynamics and propagation of electromagnetic waves.
4. To understand the basic Physics of waveguides and electromagnetic wave propagations.

Course Outcomes:

The specific outcomes of this course are as under:

1. Understand the basics of Electrostatics, Poisson Laplace equations, boundary conditions and electrostatic energy in dielectric media.
2. Learn about Magneto statics, current density, continuity equation, magnetic moment and energy in the magnetic field.
3. Understand the basics of electrodynamics, faradays laws of induction, displacement current, Maxwell’s equations, conservation of energy and momentum in electromagnetic fields.
4. Learn about electromagnetic waves, propagation of waves in linear media, reflection and transmission at normal and oblique incidence, skin depth and refection at conducting surface.

Unit	Content	Hours

I	**Electrostatics:** Divergence and curl of electrostatic field, Gauss law in integral and differential forms, Poisson and Laplace equations, Boundary conditions and uniqueness theorem, electrostatic potential energy and energy density of a continuous charge distribution. Multipole expansion of the potential and energy of a localized charge distribution, monopole and dipole terms, electric field of a dipole, dipole-dipole interaction. Electrostatic fields in matter, polarization.	15
II	**Magnetostatics:** Current density, continuity equation, magnetic field of a steady current, the divergence and curl of B, Ampere's law, magnetic vector potential, multipole expansion of vector potential of a localized current distribution, magnetic moment. Torques and forces on magnetic dipoles, effect of a magnetic field on atomic orbits. Magnetic fields in matter, magnetostatic boundary conditions, magnetic scalar potential. Energy in the magnetic field.	15
III	**Electrodynamics:** Electromotive force, Faraday law of induction, Maxwell's equations, displacement current, Maxwell equations in matter, boundary conditions. Vector and scalar potentials. Continuity equation, Poynting's theorem, momentum, Maxwell's stress tensor. **Electromagnetic Waves:** Introduction: reflection, transmission and polarization of waves. Propagation of waves in linear media, reflection and transmission at normal and oblique incidence, Electromagnetic waves in non conducting and conducting medium, skin depth, reflection at conducting surface.	15
IV	**Waveguides:** Fields at the surface and within a conductor, modes in rectangular waveguide, TE waves in a rectangular wave guide, Co axial transmission line and cylindrical cavities. Plasma Physics: Plasma behavior in magnetic field, plasma as a conducting fluid magneto hydrodynamics, magnetic confinement Pinch effect. **Electromagnetic Radiation:** Vector and scalar potentials. Gauge transformations, Lorentz gauge, Coulomb gauge. Retarded Potentials, Lenard Wiechert potentials, fields of a moving point charge. Electric dipole radiation, Magnetic dipole radiation, Power radiated by a point charge, Larmor formula, Power radiated by a point charge with collinear velocity and acceleration. Bremsstrahlung radiation, radiation from a charged particle moving in a circular	15

	orbit.	

Text Books

1. Classical Electrodynamics: J.D. Jackson , Wiley Eastern Ltd., Bangalore (1978)
2. Introduction to Electrodynamics: D.J.Griffiths, Prentice Hall of India, Ltd., New Delhi (1995).

Reference Books

1. Electromagnetics: B.B. Laud. Wiley Eastern Ltd., Bangalore (1987)
2. Classical Electromagnetic Radiation: J.B. Marion, Academic press, New York (1968).
3. Classical Electrodynamics; S P Puri, Tata McGraw Hill Publishing Company Ltd., New Delhi, (1990).

Formative Assessment for Theory	
Assessment Occasion/ Type	Marks
Internal Assessment Test 1	10
Internal Assessment Test 2	10
Total	20
Formative Assessment as per Guidelines	

Discipline Specific Course (DSC)

Course Title: Statistical and Thermal Physics
Course Code: A4PHY014T

Type of Course	Theory/ Practical	Credits	Instruction Hour per Week	Total No. of Lectures/ Hours/ Semester	Duration of Exam in Hours	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	Theory	04	04	60	03	20	80	100

Learning Objectives:

1. To provide basic theoretical background of classical statistics.
2. To give the basic concepts of phase space, probability and thermal equilibrium.
3. To discuss the approaches in quantum statistics and condition for statistical equilibrium.
4. To familiarize students with Bose-Einstein and Fermi-Dirac distributions and B-E condensation.
5. To discuss the fluctuations, Brownian motion, Langevin theory and Einstein relation for mobility.
6. To familiarize the equation for random motion, random walk problem and spectral density.
7. To familiarize the student with Fokker-Planck equation and its applications.
8. To give basic knowledge of reversible, irreversible processes and Onsager's reciprocity relations.
9. To understand the concept of Saha theory of ionization and its application in dissociation of gas.
10. To give the knowledge of superfluid properties of liquid ^{4}He, liquid ^{3}He and ^{3}He-^{4}He mixture.

Course Outcomes:

The specific outcomes of this course are as under:

1. Understand the basic postulates of statistical mechanics, different types of ensembles, fundamental differences between microstates and macrostates.
2. Learn about Maxwell-Boltzmann distribution and different types of partition functions for the system of particles and apply these to calculate important thermodynamic quantities.
3. Learn the fundamental differences between classical and quantum statistics and learn about postulates of quantum statistical mechanics.

4. Formulate the quantum statistical distribution laws, viz. Fermi-Dirac (FD) and Bose-Einstein (BE) statistics and origin of Bose-Einstein condensation
5. Understand the application of Fermi-Dirac statistics to the theory of free electrons in metals; phonons and specific heats of solids.
6. Understand the application of Bose Einstein statistics to photon gas, derivation of Planck's law of black body radiation.
7. Understand the mean, variance, standard deviation, fluctuations in ensembles and quantum gases and their analysis.
8. Describe theoretical basis of Brownian motion on the basis of Langevin approach.
9. Understand the concept of random walk, Einstein relation for mobility and diffusion, time dependence of fluctuations, their spectral analysis and applications in noises.
10. Learn the Fokker-Planck equation and its application for Brownian motion and Maxwellian velocity distribution of particles.
11. Understand the reversible and irreversible thermodynamic processes, analysis of Onsager reciprocity relations in thermoelectric phenomena.
12. Learn the Kubo relations and electrical conductivity, dielectric constant, Kramers-Kronig dispersion relations.
13. Understand the Saha theory of ionization of a gas in thermal equilibrium to the temperature and pressure and dissociation of gas.
14. Understand the quantum theory of superfluity in liquid ^{3}He and ^{3}He-^{4}He mixture; phase diagrams; formation of Cooper pairs; Leggett effect.

Unit	Content	Hours
I	**Classical Statistics:** Basic postulates of statistical mechanics, phase spaces, Liouville equation; concept of ensembles; ergodic hypotheses; postulate of equal a proiri probability; microstates and macrostates; general expression for probability; thermal equilibrium; principle of detailed balance; canonical ensemble: most probable distribution of energies, Maxwell-Boltzmann distribution; thermodynamic relations in canonical ensemble; canonical partition function; micro canonical ensemble; grand canonical ensemble, grand partition function. Partition function for the system and for the particles, translational	

	partition function; Gibbs paradox: Sackur-Tetrode equation; Boltzmann equipartition theorem; rotational partition function; vibrational contribution to thermodynamic quantities: Einstein relations; electronic partition function.	15
II	**Quantum Statistics:** Postulates of quantum statistical mechanics, ideal quantum gases, quantum statistics in classical limit, symmetric and antisymmetric wave functions for indistinguishable particles; condition for statistical equilibrium; ensembles in quantum mechanics; quantum distribution functions: Bose-Einstein and Fermi-Dirac distributions; ideal Bose and Fermi gases: their properties at high temperature and densities; weak and strong degeneracy of perfect gases; application of Fermi-Dirac statistics to the theory of free electrons in metals; phonons and specific heats of solids. Bose-Einstein condensation; application of Bose-Einstein statistics to photon gas, derivation of Planck's distribution law, comments on the rest mass of photons, thermodynamics of black body radiation. Diamagnetism, paramagnetism, and ferromagnetism: Ising model.	15
III	**Fluctuations and Brownian Motion:** Mean, variance, and standard deviation; Fluctuations in canonical, grand canonical and microcanonical ensembles, number fluctuations in quantum gases. Brownian motion: Langevin equation, random walk problem. Diffusion: Einstein relation for mobility. Time dependence of fluctuations: power spectrum, spectral density; persistence and correlation of fluctuations; Wiener-Khinchin theorem, lossless transmission line argument: Johnson noise, Nyquist theorem; shot noise; Fokker-Planck equation: applications of Fokker-Planck equation for Brownian motion and Maxwellian velocity distribution of particles.	15
IV	**Irreversible Thermodynamics:** Reversible and irreversible processes, nonequilibrium processes; Onsager reciprocity relations and their derivations; thermoelectric phenomena, linear response theory, Kubo relations: electrical conductivity, dielectric constant, Kramers-Kronig dispersion relation, fluctuation dissipation theorem; Saha theory of ionization: dissociation of gas. **Liquid Helium:** Phase diagram, superfluid properties of ^{4}He, two fluid model, thermo-mechanical, fountain and mechano-caloric effects, quantum theory of	

	superfluity in liquid ^{3}He and ^{3}He-^{4}He mixture; phase diagrams; formation of Cooper pairs; Leggett effect.	15

Text Books:

1. Statistical mechanics and properties of matter: Theory and applications: E.S.R. Gopal, John Wiley & Sons, New York (1974).
2. Statistical mechanics (3rd ed.): B.K.Agarwal and M. Eisner, New Age International (P) Ltd. Publishers, New Delhi (2013).

Reference Books:

1. Fundamentals of statistical & thermal Physics: F.Reif, McGrawHill Ltd., New Delhi (1965).
2. Thermal Physics and Statistical Mechanics: Roy S.K., New Age Intemational Pub., 2000.
3. Elementary Statistical Physics: C. Kittel, John Wiley & Sons, New York (1958).
4. Statistical mechanics; Theory & applications; S.K.Sinha, TMH Pub.Ltd., New Delhi (1990).
5. Statistical Thermodynamics: M.C. Gupta, New Age Publishers (2nd ed.) (2010).
6. Statistical Mechanics, R.K. Pathria & Paul D. Beale, Bufferworgh Heinemann (2nded. 2012).
7. Fundamentals of Statistical Mechanics: B.B. Laud, New Age International (2012).

Formative Assessment for Theory	
Assessment Occasion/ Type	Marks
Internal Assessment Test 1	10
Internal Assessment Test 2	10
Total	20
Formative Assessment as per Guidelines	

Discipline Specific Elective (DSE)

Course Title: Molecular Spectra and Structure of Polyatomic Molecules
Course Code: A4PHY105AT

Type of Course	Theory/ Practical	Credits	Instruction Hour per Week	Total No. of Lectures/ Hours/ Semester	Duration of Exam in Hours	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSE	Theory	04	04	60	03	20	80	100

Learning Objectives:

1. To introduce the concept of symmetry and to make students understand the correlation between symmetry and rotational spectra IR and Raman spectra of polyatomic molecules.
2. To make students to understand the interpretation of vibrational IR and Raman spectra of polyatomic molecules.
3. To make students to know the analysis of vibrational & electronic spectra for characterizing molecular structure and properties.

Course Outcomes:

At the end of this course, students will learn:

1. Interpretation of vibrational IR and Raman spectra of polyatomic molecules.
2. Methods of determining vibrational properties of polyatomic molecules based on IR and Raman spectra.
3. How to apply combined analysis of vibrational & electronic spectra for characterizing vibrational properties that may be correlated to identification of molecules, structure and other phenomena.

Unit	Content	Hours
I	**Molecular Symmetry**: Symmetry elements, Point Groups (Cs, C_i, C_{2v}, C_{3v}, $C_{\infty v}$, D_{3h}, D_{6h}, $D_{\infty h}$, D_{3d}, T_d) **Rotational Spectra:** Classification of molecules as rotors: Linear, Symmetric top, Spherical top, Asymmetric top molecules. Energy levels: thermal distribution, symmetry properties and statistical weights of rotational levels, Spectrum; IR and Raman spectra.	15

II	**Molecular Vibrations:** Separation of rotational and vibrational motions; the secular equation for small vibrations (classical treatment). Normal modes of vibration. Application to simple linear systems(two/three mass points), Normal coordinates. Determination of symmetry species of normal modes (symmetric bent XY_2 /XY_3 type molecules) based on the group theoretical approach. **Vibrational Energy levels and Selection Rules:** The Schrodinger's vibrational wave equation for harmonic oscillator model of polyatomic molecules. Energy levels, Vibrational Spectra and Degeneracy. Selection Rules for Infrared and Raman Spectra for harmonic and anharmonic models.	15
III	**The Spectra-Structure Correlations:** Functional groups and fingerprint regions in the vibrational spectrum. The invariance of force constants, origin of Group frequencies and spectra-structure correlations. Rule of mutual exclusion, Fermi resonance. Identification and assignment of IR and Raman bands of water, carbon dioxide, ammonia, carbon tetrachloride and methane. Applications: Identification of an unknown compound using its IR and Raman spectra.	15
IV	**Electronic Structure & Spectra:** Classification of Electronic States based on angular momentum, spin, multiplet components. Types of electronic transitions (with examples); Allowed transitions, general selection rules, spin selection rules. Forbidden transitions: Magnetic and electric quadrupole transitions.	15

Text Books:

1. Molecular Vibrations: E. Bright Wilson, J. C. Decius, P. C. Cross, Dover Pub., Inc., N.Y. (1955)
2. Introduction to the theory of Molecular Vibrations and Vibrational Spectroscopy: L A Woodward, Clarendon Press, Lon, (1976).
3. Vibrational Spectroscopy – Theory and Applications: D. N. Sathyanarayana, New Age International Pub., New Delhi (1996).
4. Fundamentals of Molecular Spectroscopy: C. N. Banwell, Tata Mc Graw-Hill, New Delhi (1983).

5. Molecular Spectra and Molecular Structure (Vol.III) - Electronic Spectra & Electronic Structure of Polyatomic Molecules: G. Herzberg, D. van Nostrand & Co. N. J. (1966).
6. Introduction to Infrared and Raman Spectroscopy: N.B. Colthup, L. H. Daly and S.E. Wiberley, Academic Press, N. Y. (3rd edition 1990).
7. Organic Spectroscopy By William Kemp 3rd Edition, PALGRAVE, New York.
8. Infrared Spectroscopy: Fundamentals and Applications by B. H. Stuart, Jhon Wiley & Sons 2004.

Reference Books:

1. Molecular Spectra and Molecular Structure (Vol.II)- Infrared & Raman Spectra of Polyatomic Molecules : G. Herzberg, D. Van Nostrand & Co. N. J. (1945).
2. Atoms & Molecules : Mitchel Weissbluth, Academic Press, N. Y. (1978).
3. Raman Spectroscopy: D. A. Long, McGraw-Hill, NY (1977).
4. Vibrating Molecules : P. Gans, Chapman & Hall, London (1971).
5. Vibration Spectra and Structure Vol. 4 : (Ed) J. R. Durig, Elsevier Sci. Pub. Co. N. Y. (1975).
6. Microwave Spectroscopy: C.H. Townes and Arthur Schawlow, McGraw Hill, 1955.
7. Interpretation of Infrared Spectra, A practical approach by John Coates, Infrared Spectroscopy, Wiley Online Library, 15th Sept, 2006.
8. Course Notes on the Interpretation of Infrared and Raman Spectra, D.W. Mayo, F.A. Miller and R.W. Hannah, Wiley-Interscience (2003).

Formative Assessment for Theory	
Assessment Occasion/ Type	Marks
Internal Assessment Test 1	10
Internal Assessment Test 2	10
Total	20
Formative Assessment as per Guidelines	

Discipline Specific Elective (DSE)

Course Title: Semiconductor Physics and Devices
Course Code: A4PHY105BT

Type of Course	Theory/ Practical	Credits	Instruction Hour per Week	Total No. of Lectures/ Hours/ Semester	Duration of Exam in Hours	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSE	Theory	04	04	60	03	20	80	100

Learning Objectives:

1. To teach the basic physics of semiconductors.
2. To understand fundamental concepts of charge transport in semiconductors.
3. To frame theoretical basis of effect of external electric/magnetic fields on charge transport.
4. To impart the importance of thin films and their method of preparation.
5. To teach various semiconductor devices and their importance in various fields.

Course Outcomes:

The specific outcomes of this course are as under:

1. Helps to understand basics of semiconductors and its carrier estimations.
2. Dynamics of charge carriers under electric, magnetic and electromagnetic fields can be understood.
3. Gives understanding of thin films and methods of their preparation.
4. Helps to gain understanding of various types of electronic devices that are useful.

Unit	Content	Hours
I	**Semiconductors:** General properties of semiconductors, Elemental and compound semiconductors, energy band structure of real semiconductors, such as Silicon, Germanium and Gallium Arsenide. **Semiconductor Career Concentration:** Doping processes of semiconductors. Carrier concentration in an intrinsic semiconductor on the basis of statistical arguments, Fermi-level career concentration as function of temperature.	

	Extrinsic semiconductors: Binding energy of impurity, impurity levels, Population of impurity levels, carrier concentration, Fermi energy and its dependence on impurity concentration and temperature.	15
II	**Transport in Semiconductors:** Electrical conductivity and mobility, their dependence on temperature and scattering mechanisms, energy gap determination. Diffusion, Einstein relation, diffusion equation and diffusion length of charge careers. **Magnetic Field Effects:** Hall effect, Hall resistance, magnetoresistance (qualitative), cyclotron resonance and effective mass determination in semiconductors. **Optical Properties:** Interband and intraband absorption, fundamental absorption, absorption edge, exciton absorption, free carrier absorption, impurity involved absorption. Experimental measurements of energy gap of semiconductor. Photoconductivity, and photoluminescence properties of semiconductors.	15
III	**Thin Film Physics:** Importance of thin films. Basics of vacuum systems and vacuum measurements. Preparation of thin films: Thermal evaporation, spray pyrolysis and spin coating. Epitaxial growth and Chemical vapor deposition, Molecular beam epitaxy (MBE), and Molecular organic chemical vapour deposition (MOCVD) methods. Thickness measurements: Electrical methods (overview of resistivity and capacitance measurements), Optical methods (optical absorption and interference) and vibrating quartz crystal method and their advantages and disadvantages. **Low-Dimensional Semiconductor Structures:** Historical background. Two dimensional electron gas system: Metal-oxide-semiconductor (MOS) junction, inversion layer, quantum well. Two-dimensional energy levels and density of states. Modulation doping, quantum well wire, quantum dot and superlattices. Quantum Hall effect and its significance (qualitative) and Coulomb blockade and single electron transport (concept).	15

IV	**Semiconductor Devices:** Formation ofa p-n junction formation at equilibrium, space charge region, and barrier potential. Mechanism of charge transport across the barrier, derivation of charge transport equation (current-voltage relation) based on diffusion theory. P-n junction under different bias condition. P-n junction in non – equilibrium: generation and recombination current, and continuity equations. Metal-semiconductor (Schottky) junction formation and its charge transport derivation. Energy gap determination by resistivity method. The barrier thickness measurement of p-n junction by capacitance method. Basic Semiconductor Devices: Tunnel diode, Gunn diode, semiconductor lasers, light emitting diode (LED), photocell and photovoltaic effect: Solar cells.	15

Text Books

1. Solid State and Semiconductor Physics: J. P. McKelvey, Harper and Row, New York (1966)
2. Solid State Physics: N. W. Aschroft and A. S. Mermin, Saunders College Publishing, New York (1976).
3. The Physics of Low Dimensional Semiconductors: J. H. Davies. Cambridge University press, (1998).
4. Elementary Solid State Physics: M.A. Omar, Addison – Wesley Pvt.Ltd., New Delhi (1993).
5. Thin Film Phenomena: K. L. Chopra. Mc Graw – Hill Book Company, New York (1969).

Reference Books:

1. Elements of Solid State Physics (2nd Ed): J.P. Srivastava, PHI Learning Pvt. Ltd., New Delhi (2009)
2. Physics of Thin Films: L. Eckertova, Cambridge University Press, Cambridge (1998).

Formative Assessment for Theory	
Assessment Occasion/ Type	Marks
Internal Assessment Test 1	10
Internal Assessment Test 2	10
Total	20
Formative Assessment as per Guidelines	

Discipline Specific Elective (DSE)

Course Title: Microprocessor and Microcontroller
Course Code: A4PHY105CT

Type of Course	Theory/ Practical	Credits	Instruction Hour per Week	Total No. of Lectures/ Hours/ Semester	Duration of Exam in Hours	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSE	Theory	04	04	60	03	20	80	100

Learning Objectives:

1. Understand the architecture and functionality of the 8085 microprocessor and 8051 microcontroller.
2. Learn command execution, arithmetic operations, and interfacing techniques with external devices.
3. Apply programming and practical problem-solving skills for microprocessor-based applications.

Course Outcomes:

At the end of this course, the students will be able to-

1. Understand the architecture of 8085 microprocessor which completes the basic foundation necessary to understand how CPU works and communicates with RAM, ROM and external devices.
2. Get information about execution of each command written in language form. This includes knowledge of arithmetic operations, looping, stacking, etc.
3. Understand Interfacing peripherals of 8085 microprocessor with 7-segment display, analog to digital system vice-versa, and additional input/output devices etc., incorporated to account the applications.
4. Gain knowledge about 8051 microcontroller architecture to programming, the complete idea of execution of commands, instructions to interfacing with external input/output devices.
5. Will be able to implement the above practically with the help of Numerical problems solving.

Unit	Content	Hours
I	Microprocessor Architecture: Introduction, microprocessor and its operations, architecture of 8085 microprocessor, memory, input and output devices, basic interfacing concepts, memory interfacing, interfacing input and output devices.	15
II	Programming of 8085: Introduction, instruction classification, instruction format and data storage, over view of instruction set of 8085, assemble and execute of programs, data transfer operations, arithmetic operations, logic operations, branch operation; Instructions for Looping, counting, and indexing, additional data transfer instructions, writing assembly language programs, debugging a program.	15
III	Programming techniques: looping, counting and indexing, 16-bit arithmetic instructions and arithmetic operations related to memory, additional data transfer, stack and subroutine conditions of assembly language. Interfacing peripherals and applications: The8085 interrupt, multiple interrupts and priorities, additional 8085 interrupts: TRAP, RST7.5, 6.5 and 5.5, triggering levels, additional I/O concepts, DMA; Interfacing A/D and D/A converters, handshaking and polling.	15
IV	Microcontroller: 8051 architecture: 8051 microcontroller hardware-I/O pins, ports and circuits-External memory-Counter and Timers-Serial data I/O Interrupts. 8051programming: instruction syntax-moving data-logical operations-arithmetic operations-branching instructions.	15

Text Books:

1. Microprocessor Architecture, Programming, and Applications with 8085/8080 A: Ramesh S. Gaonkar, New Age International Publishers Ltd.
2. The 8051 Microcontroller, Architecture, Programming and Applications, Kenneth JAyala, International Thompson Publishing.

References Books:

1. Microcomputer theory and Applications: Rafiquzzaman Mohamed, John Wiley and Sons, New York (1987)
2. Introduction to Microprocessors (3rd Edition): Aditya P. Mathur, Tata – Mc Graw –Hall Publishing Company Ltd., New Delhi (1989)
3. The 8051 Microcontroller and Embedded systems: M.A. Mazidi, J.G. Mazidi, Pearson, Prentice Hall (2005)

Formative Assessment for Theory	
Assessment Occasion/ Type	Marks
Internal Assessment Test 1	10
Internal Assessment Test 2	10
Total	20
Formative Assessment as per Guidelines	

Discipline Specific Elective (DSE)

Course Title: Nuclear Models, Nuclear Reactions and Weak Interactions
Course Code: A4PHY105DT

Type of Course	Theory/ Practical	Credits	Instruction Hour per Week	Total No. of Lectures/ Hours/ Semester	Duration of Exam in Hours	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSE	Theory	04	04	60	03	20	80	100

Learning Objectives:

1. To give the evidences for nuclear shell structure and understand the energy levels.
2. To give the knowledge about the collective nuclear model and vibrational energy levels.
3. To know the concept of cross section and resonance theory of scattering and absorption.

4. To learn the importance of heavy ion reactions and different models.
5. To understand the concept of conservation laws and parity in weak interactions.
6. To know the about universality of weak interactions nucleon-antinucleon systems, CP invariance, CP violation and CPT theorem

Course Outcomes:

After completion of this course, a student should be able to

1. Learn the evidences for nuclear shell structure and understand the energy levels according to the infinite square well potential and harmonic oscillator potential.
2. Get knowledge about the collective nuclear model, vibrational energy levels of even nuclei and rotational energy levels of deformed even-even nucleus.
3. Know the concept of cross section and apply it to resonance theory of scattering and absorption and learn the Briet –Wigner formula for scattering and reaction.
4. Learn the importance of heavy ion reactions, electromagnetic interactions: Coulomb excitation, close encounters: elastic scattering, Blair model, critical angle.
5. Understand the weak interactions, conservation laws, G parity of pion state, G parity in nucleon-antinucleon systems, CP invariance, CP violation and its experimental evidence.
6. Learn about universality of weak interactions, charged weak quark current and suppressed weak decays, Cabibbo-Kobayashi-Maskawa (CKM) Matrix.

Unit	Content	Hours
I	**Shell Model:** Extreme single particle model-energy levels according to Infinite square well potential and harmonic oscillator potential, effect of spin orbit interaction, prediction of ground state spin – parity of odd A nuclei. Single particle model-Total spin J for various configuration. evidences for nuclear shell structure. Nuclear isomerism, Magnetic moment, configuration mixing. Stripping reactions, beta decay Nordhiem's rules, **Collective Model:** Rotational energy levels of deformed even-even nuclei, odd-A nuclei: Energy spectrum and wave function, magnetic dipole moment, collective vibrational excitations, nuclear moments. **Nilsson Potential:** its importance in the predictions of the nuclear spin.	15
II	**Nuclear Reaction-I:** Background information for nuclear reactions, cross-sections, gross-structure problem, features of direct reaction model and	

	compound nucleus model. Partial wave analysis of nuclear reactions, expressions for scattering and reaction cross sections and their interpretation: shadow scattering, resonance theory of scattering and absorption, overlapping and isolated resonance, Breit-Wigner formula for scattering and reaction shape of cross section curve near a resonance. Inverse nuclear reactions, principle of detailed balance, optical model, mean free path, forms and features of optical potential and its parameters for elastic scattering.	15
III	**Nuclear Reaction-II:** Transfer reactions, semi-classical description, plane wave Born approximation (PWBA), its predictions of angular distributions, distorted wave Born approximation (DWBA), spectroscopic factors, transfer reactions and the shell model. **Heavy ion reactions:** Special features of heavy ion reactions, electromagnetic interactions: Coulomb excitation, close encounters: elastic scattering, Blair model, critical angle, McIntyre model, Rainbow scattering and diffraction, deflection function. Grazing interactions: Particle transfer. Direct and head on collision: compound nucleus and quasi molecule formations.	15
IV	**Particle Physics:** Weak interactions, Conservation laws, G parity of pion state, G parity in Nucleon-anti nucleon systems, CP invariance, CP violation and its experimental evidence. Time reversal, CPT theorem and physical consequences. Leptonic and semi-leptonic interactions, Fermi's theory of beta decay, helicity and handedness, two component theory of neutrinos, Fermi's relativistic theory of Beta decay: V-I interactions, Universality of weak interactions, Intermediate vector Bosons Cabibbo theory, charged weak quark current and suppressed weak decays, GIM mechanism and Charmed Quarks, Cabibbo-Kobayashi-Maskawa (CKM) Matrix.	15

Text Books:

1. Nuclear Physics : Theory and Experiment : R.R.Roy and B. P. Nigam, Wiley Eastern Publications (1986).
2. Atomic and Nuclear Physics volume II : S. N. Goshal, S. Chand and company (1998).

3. Introductory Nuclear Physics : K. S. Krane, Wiley and sons (1988).
4. Nuclear Reaction with heavy Ions : Reiner Bass, Springer – Verlag (1980).
5. Heavy Ion Reaction : R. A. Broglia and Aage Winter, Addison Wesley (1991).
6. Nuclear reaction : R. Sing and S. N. Mukherjee, New Age International (1996).
7. Nuclear Physics Experimental& Theoretical: H.S. Hans, New Age International, (2001).

Reference Books:

1. Subatomic Physics: Nuclei and Particles (Volume II): Luc Valentin North Holland (1981).
2. Subatomic Physics (Second Edition): Hans F and E. M. Henley, Prentice Hall (1991).
3. Introduction to Nuclear Physics: Herald. A. Enge Addison-Wesley (1983).
4. Introduction to Nuclear Physics: Samuel S. M. Wong Prentice – Hall (1996).
5. Atomic Nucleus: R. D. Evans, Tata McGraw-Hill (1982).
6. Theoretical Nuclear Physics Volume I : Nuclear structure : Amos de Shalit and Herman Feshbach, John Wiley (1974).
7. Nuclear and Particle Physics: W. Burcham and M. Jobes, Addison – Wesley (1998).
8. Introduction to Elementary Particles, D. Griffiths: John Wiley, (1987).
9. Quarks and Leptons, F. Halzen& A.D. Martin, John Wiley & Sons, New York, (1984).
10. Unitary Symmetry and Elementary Particles,D.B.Lichtenberg:2nd Ed, Academic Press, (1978).
11. Elementary Particles, J. M. Longo:II edition, Mc Graw-Hill, New York, (1973).
12. Particles and Nuclei: Povh, Rith, Scholz, Zetsche, Springer (1999).
13. Subatomic Physics: Hans Frauenfelder and Ernest M. Henley, Prentice Hall (1991).
14. Introduction to High Energy Physics: Donald H. Perkins, Addison Wesley Pub. (1987).

Formative Assessment for Theory	
Assessment Occasion/ Type	Marks
Internal Assessment Test 1	10
Internal Assessment Test 2	10
Total	20
Formative Assessment as per Guidelines	

Discipline Specific Elective (DSE)

Course Title: Lasers, Nonlinear Optics and Nonlinear Spectroscopy
Course Code: A4PHY106AT

Type of Course	Theory/ Practical	Credits	Instruction Hour per Week	Total No. of Lectures/ Hours/ Semester	Duration of Exam in Hours	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSE	Theory	04	04	60	03	20	80	100

Learning Objectives:

1. This Course will provide advanced knowledge starting from the basics to techniques to applications in laser physics and its technology, nonlinear optics and laser spectroscopy including nonlinear laser Raman spectroscopy.
2. Lasers being widely used in diverse applications, the students will study basics, design and operational aspects with a view to apply this knowledge to on- site diverse laser systems in research labs/industries.
3. Nonlinear optics topic will introduce to students special optical phenomena governed by a new set of principles and wide ranging devices used in quantum science, laser and communication technologies.
4. These are advanced level topics which expose the students to the present- day frontiers, techniques and applications in quantum science and technologies; life sciences.

Course Outcomes:

At the end of the course, students will learn:

1. Principles, working and scientific and practical applications of different laser types.
2. How design parameters will produce lasers.
3. How intense lasers can be used to produce nonlinear optical effects & their exploitation in the working of lasers.
4. How high-resolution spectroscopy is achievable based on principles of nonlinear effects, lasers and physical optics.

5. How nonlinear Raman effects can be produced by intense laser as radiation sources combined with physical optics. In addition, wide ranging applications in spectroscopy and other fields.

Unit	Content	Hours
I	**Laser Physics:** Absorption and Emission of Light. Cavity modes, thermal radiation, Planck's law. Absorption, Induced and Spontaneous emissions. Temporal and Spatial coherence of radiation. **Laser Resonators:** Basic elements of a laser; threshold condition and rate equations for a four-level system. Open optical resonators; confocal resonators; general spherical resonators; stable and unstable resonators (simple treatment). Active resonators and laser modes. Gain Saturation; Spatial Hole Burning; Multimode lasers and gain competition. Experimental realization of single-mode. Controlled wavelength tuning of single-mode lasers. Linewidths of single-mode lasers	15
II	**Laser Types:** General principles, construction, excitation mechanism and applications: Argon and Krypton ion lasers. Carbon-dioxide laser. Dye lasers (Rhodamine 6G type): flash- pumped and pulsed laser-pumped dye lasers. Nd:YAG laser; Nd:YVO4 laser; Ti:sapphire laser. Semiconductor diode lasers (simple systems – homo-and hetero-structure type). Applications covering all the laser types.	15
III	**Nonlinear Optics:** Nonlinear optical media; the nonlinear wave equation. Second-order nonlinear optics; the electro-optic effect; the second harmonic generation(SHG). Three- wave mixing: frequency and phase matching conditions; frequency up- conversion/frequency down-conversion; optical parametric amplifier/oscillator. Third- order nonlinear optical effects: three-wave/four-wave mixing: frequency and phase matching conditions; the third harmonic generation (THG); self-phase modulation; self- focusing. Illustrations and examples covering all the topics.	15

IV	**Nonlinear Spectroscopy:** Linear and nonlinear absorption. Hole burning; the Lamb dip. Doppler-limited/Doppler-free spectroscopies: principle and experimental method of saturation spectroscopy; polarization spectroscopy; two-photon absorption and spectroscopy. Illustrations and applications. Nonlinear Raman Spectroscopy: Stimulated Raman scattering, Coherent Anti Stokes Raman Spectroscopy (CARS), Hyper-Raman effect, Resonance Raman effect and associated experimental methods. Illustrations and applications.	15

Text Books:

1. Laser Spectroscopy (Vol 1, 2, 4th ed, online): W. Demotroder, Springer (2008).
2. Fundamentals of Photonics (3rded, online): Bahaa E.A.Saleh and Malvin Carl Teich, John Wiley & Sons (2019).
3. Modern Spectroscopy (4th ed, online), J.Michael Hollas, John Wiley, (2004).
4. Laser Fundamentals: W. Silfvast, Cambridge Univ. Press.
5. Laser and Nonlinear Optics: B.B.Laud, Wiley Eastern Ltd., New Delhi(1991).
6. Introduction to Fiber Optics: A. Ghatak & K. Thyagarajan, Cambridge Univ. Press (1999).
7. Lasers: Theory of Applications: A. Ghatak & K. Thyagarajan, MacMillan India (1981).
8. Optical Fiber & Communication Principles & Practice: John M. Senior, Prentice Hill Intl. Ltd. London (1992).

Reference Books:

1. Laser Electronics: Joseph T. Verdeyen, Prentice Hall of India Pvt Ltd. New Delhi.
2. Principles of Lasers: O. Svelto, Plenum Press, N.Y(1982).
3. High Resolution Spectroscopy: K. Shimoda, Springer Verlag, Berlin (1976).
4. Raman Spectroscopy: D.A. Long, McGraw Hill Intl. Book Co (1977).
5. Laser Principles & Applications: J. Wilson & J.F.B. Hawkes, Prentice Hall Intl. Inc.(1983).
6. Laser Spectroscopy: H. Walther, Springer Verlag, Berlin (1976).

Formative Assessment for Theory	
Assessment Occasion/ Type	Marks
Internal Assessment Test 1	10
Internal Assessment Test 2	10
Total	20
Formative Assessment as per Guidelines	

Discipline Specific Elective (DSE)

Course Title: Superconductivity and Advanced Materials
Course Code: A4PHY106BT

Type of Course	Theory/ Practical	Credits	Instruction Hour per Week	Total No. of Lectures/ Hours/ Semester	Duration of Exam in Hours	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSE	Theory	04	04	60	03	20	80	100

Learning Objectives:

1. To learn important effects and development of advanced materials.
2. To teach the concept of nanoscience and classification and preparations of nanomaterials.
3. To understand the class of nanomaterials and their detailed characterization techniques.
4. To learn about the overview on advanced materials like glasses, polymers and liquid crystals.

Course Outcomes:

The specific outcomes of this course are as under:

1. Discovery of superconductivity and its important properties can be studied.
2. Helps to have a clear understanding of nanoscience and its importance.
3. The usefulness of various nanomaterials and their characterization can be studied.
4. Give a overview on the advanced materials like glasses, polymers and liquid crystals.

Unit	Content	Hours
I	**Superconductivity:** Historical perspective of low temperature physics. Superconductivity and effect of magnetic field. Heat capacity, isotope effect, and energy gap, infrared properties. Type I and type II superconductors. Thermodynamics of superconductivity, London equations, coherence length, flux quantization in superconducting ring, duration of persistent current. High T_c superconductors (qualitative discussion only). BCS Theory: Elements of BCS theory and its important accomplishments on basic experimental results. **Tunneling:** Basic concepts of tunneling, metal-insulator-superconductor and superconductor-insulator-superconductor tunneling (Cooper-pair tunneling): A. C. and D. C. Josephson effects and their importance.	15
II	**Nanomaterials:** Historical perspectives. Nanoscience, Quantum mechanics of Nanoscience: Particle in deep potential well (One-dimensional) its eigen values and egien functions. Its relevance to the Nanoscience (Quantum Confinement Effect), density of electronic states for 0-D, 1-D, 2-D and 3-D materials. Synthesis of nanoparticles: Qualitative discussion on general synthesis of nanomaterials by gas, liquid and solid phases. Gas phase synthesis: Thermal evaporation method, Solution routes: Colloidal syntheses, nucleation growth of nanoparticles, role of capping molecules and their importance in controlling the optoelectronic properties of nanomaterials. Langmuir-Blodgett (LB) method of preparation of nanometer thick films. Micro-emulsion synthesis of nanoparticles. Self-assembly synthesis thin films with some examples.	15
III	**Class of Nanomaterials:** Synthesis of metal nanoparticles by colloidal route and their important optoelectronic properties. Synthesis of semiconducting nanoparticles by colloidal route and their size dependent optoelectronic properties. Exciton formation and effective mass approximation method of estimation of optical band gap on the size of nanoparticles. Carbon based nanoparticles: Graphene, reduced graphite oxides, carbon quantum dots (CQDs) and carbon nanotubes. General importance of carbon based nanoamaterials. **Characterization Techniques:** X-ray diffraction, estimation of particle size, optical spectroscopy, scanning electron and transmission electron microscopy.	

	And their importance in characterization of nanomaterials. The working principle of scanning tunneling and atomic force microscopy and their advantages.	15
IV	**Amorphous Semiconductors:** Concept amorphous materials, formation mechanisms and preparation. Importance of amorphous semiconductors and their classification, electronic band structure, charge conduction mechanisms, optical absorption comparison with their crystalline counter parts, electrical switching (Ovonic diode). **Polymers:** Basic concepts, classification of polymers, effect of temperature. Electrical conduction in ordinary polymers. Conducting polymers, classes, synthesis, charge transport mechanisms. General applications of conducting polymers **Liquid Crystals:** Classification, orientational order and inter-molecular forces, magnetic effects, optical properties and general applications.	15

Text Books:

1. Introduction to Solid State Physics: C. Kittel, Editions: 2,5,6,7, Wiley Eastern Ltd., Bangalore.
2. Elementary Solid State Physics: M.A. Omar Addison-Wesley Pvt. Ltd., New Delhi, (2000).
3. Nanotechnology: Principles and Practices, Sulabha K. Kulkarni, Capital Publishing Company, India, 3rd Edition (2016).
4. Nano: The Essentials: T. Pradeep, Tata McGraw-Hill Publishing New Delhi (2007).
5. Fundamentals of Nanoscience, S.L. Kakani & ShubhraKakni, New Age International Publishers, India (2017).
6. Amorphous Semiconductors: D. Adler, CRC, London, (1972).
7. Introduction to Nanotechnology: C.P. Poole Jr. and F.J. Owens, John Wiley and Sons, Singapore (2006).

Reference Books:

1. Solid State Physics : A. J. Dekker, Macmillan India Ltd., Bangalore (1981)
2. Solid State Physics: F. W. Aschroft and N. D. Mermin, Saunders College Publishing, New York, (1976).

3. Electronic processes in Non-Crystalline Materials : N. F. Mott and E. A. Davis, Clarendon press, Oxford, (1979).
4. Nanoscale Materials – (Ed) L.M. Liz-Marzan and P.V.Kamat, (Kluwer, 2003)
5. Nanostructured Materials and Nanotechnology, (Ed) H.S.Nalwa, (Academic,2002)
6. Elements of Solid State Physics (2nd Ed): J.P. Srivastava, PHI Learning Pvt. Ltd., New Delhi (2009)
7. Solid State Physics, J.D. Patterson and B.C. Bailey, Springer Verlag, Berlin (2007)

Formative Assessment for Theory	
Assessment Occasion/ Type	Marks
Internal Assessment Test 1	10
Internal Assessment Test 2	10
Total	20
Formative Assessment as per Guidelines	

Discipline Specific Elective (DSE)

Course Title: Analog and Digital Modulation
Course Code: A4PHY106CT

Type of Course	Theory/ Practical	Credits	Instruction Hour per Week	Total No. of Lectures/ Hours/ Semester	Duration of Exam in Hours	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSE	Theory	04	04	60	03	20	80	100

Learning Objectives:

1. Understand amplitude, frequency, and pulse modulation techniques in electronic communication.

2. Learn digital communication fundamentals, including intersymbol interference and pulse shaping.
3. Apply modulation and communication concepts to practical problems and numerical analysis.

Course Outcomes:

Upon completion of this course, the students will be able to-

1. Get a complete knowledge of use of modulation in electronic communication, amplitude modulation, the instrumentation and techniques of amplitude modulation, transmitters and receivers used in amplitude modulation and their functioning.
2. Understand theory of frequency modulation, FM instrumentation, its advantages over AM, experimental techniques of FM, etc.
3. Learn the basics of pulse modulation, types of pulse modulation, pulse amplitude modulation, pulse position modulation, pulse width modulation and other methods that form basis of Digital Communication.
4. Deal with communication techniques which lie in the base band region with explanation of inter symbol interference, pulse data transmission, scrambling and descrambling, pulse shaping, etc.
5. Digital communication systems reflect the idea of achieving modulation of message signal with low power and its versatile use modern days. Will be able to implement the above practically with the help of Numerical problems solving.

Unit	Content	Hours
I	**Amplitude Modulation:** Amplitude Modulation, Theory, Frequency spectrum of the AM wave, Representation of AM, Power relations in the AM wave, Generation of AM, Basic requirements, Modulated transistor amplifiers, Single Sideband Techniques, Evolution and Description of SSB, Effect of nonlinear resistance on added signals, Suppression of unwanted Sideband, filter system, phase shift method, System evaluation and comparison, Vestigial sideband transmission, AM transmitter and receiver, super heterodyne receivers	15
II	**Frequency Modulation:** Theory of Frequency and Phase Modulation, Description of Systems, Mathematical Representation of FM, Frequency	

	Spectrum of FM Wave, Phase Modulation, Intersystem Comparisons, Noise and Frequency Modulation, Effects of Noise on Carrier Noise Triangle, Pre emphasis and De emphasis, Comparison of Wideband and Narrowband FM, Stereophonic FM Multiplex System, Generation of Frequency Modulation, Direct Methods, Stabilized Reactance Modulator AFC.	15
III	**Analog Pulse Modulation:** Sampling theorem for band pass signals, Pulse Amplitude modulation: generation and demodulation, Time division multiplexing, Digital multiplexer, PPM generation and demodulation, PWM, Spectra of Pulse modulated signals, SNR calculations for pulse modulation systems. Waveform coding: quantization, Pulse code modulation, Line codes, Regenerartion, Differential pulse-code modulation and demodulation.	15
IV	Pulse Shaping, Nyquist criterion for zero ISI, Correlative level coding, Signaling with duo binary pulses, Eye diagram, Base band pulse data transmission: Matched filter receiver, M-ary pulse amplitude modulation, transmission, Properties of matched filters, Inter symbol interference, Signal space analysis, Geometric representation of signals, Gram Schmidt Orthogonalization Procedure. Digital modulation schemes: Coherent Binary Schemes: ASK, FSK, PSK, MSK. Calculation of average probability of error for different modulation schemes.	15

Text Books:

1. Electronic communications, 4th edition: Dennis Roddy and John Coolen, Prentice – Hall of India Pvt. Ltd. New Delhi (1997).
2. Modern Communication Systems – principles and applications: Leon W. Couch II, Prentice Hall of India Pvt. Ltd. New Delhi (1998).
3. Electronic Communication systems – 4th edition: George Kennedy and Bernard Davis, Tata McGraw – Hill Publishing Company Ltd., New Delhi (1999).
4. Communication Systems, 3rd ed., Simon Haykin, John Wiley & Sons.
5. Modern Digital and Analog Communication, 3rd Ed., B.P. Lathi, Oxford University Press.

Reference Books:

1. Communication Systems: Simon Haykin, Wiley Eastern Ltd., New Delhi (1978).
2. Radio Engineering: G. K. Mittal, Khanna Publishers, Delhi (1998).

Formative Assessment for Theory	
Assessment Occasion/ Type	Marks
Internal Assessment Test 1	10
Internal Assessment Test 2	10
Total	20
Formative Assessment as per Guidelines	

Discipline Specific Elective (DSE)

Course Title: Nuclear Reactors and Nuclear Decays
Course Code: A4PHY106DT

Type of Course	Theory/ Practical	Credits	Instruction Hour per Week	Total No. of Lectures/ Hours/ Semester	Duration of Exam in Hours	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSE	Theory	04	04	60	03	20	80	100

Learning Objectives:

1. To study nuclear fission, Bohr-Wheeler theory, barrier penetration and evidence for the existence of second well in fission isomers and fusion processes
2. To study reactor theory, slowing down of neutrons, neutron diffusion and classification of reactors.
3. To study beta decay, universal beta decay, non-conservation of parity, discovery of Wand Z bosons and double beta decay.
4. To study gamma decay determination of gamma decay transition probability for single particle transition in nuclei-Weisskopf's estimates, comparison with experimental values.

5. To study internal conversion, lifetime measurements, angular dipole-dipole transitions and polarization studies.

Course Outcomes:

1. Learn the theory of nuclear fission, evidence for the existence of second well in fission isomers, nuclear fission with heavy ions and fission-fission time scale.
2. Learn nuclear fusion processes, controlled thermonuclear reactions and magnetic confinement for controlled thermonuclear fusion processes.
3. Learn reactor theory, slowing down of fast neutrons, diffusion of neutrons, Fermi age equation, pile equations, buckling-critical size for spherical and rectangular piles, and classification of reactors.
4. Learn beta decay, selection rules, detection of neutrino and its properties, non-conservation of parity, and discovery of W and Z bosons.
5. Learn gamma decay, Weisskopf's estimates: comparison with experimental values, lifetime measurements, angular correlation for dipole-dipole transitions, gamma-gamma correlation and polarization studies.

Unit	Content	Hours
I	**Nuclear Fission:** Types of Fission, distribution of fission products, fission energy distribution, Spontaneous fission, Bohr-Wheeler theory of nuclear fission, saddle point, scission point, barrier penetration, shell correction to the liquid drop model, Strutinsky's smoothing procedure, evidence for the existence of second well in fission isomers. Nuclear fission with heavy ions. Nuclear fission-fission time scale. **Nuclear Fusion:** Basic fusion processes, characteristics of fusion, fusion in stars. Controlled thermonuclear reactions. magnetic pressure, pinch effect, magnetic confinement systems for controlled thermonuclear fusion.	15
II	**Slowing Down of Neutrons:** Slowing down of neutrons by elastic collisions, – logarithmic decrement in energy, number of collisions for thermalization, slowing down power, moderating ratio. **Neutron Diffusion:** Elementary theory of diffusion of neutrons, spatial distributions of neutron flux (I) in an infinite slab with a plane source at one end	

	(II) in an infinite medium with point source at the center – reflections of neutrons – albedo. **Reactor Theory:** Slowing down density – Fermi age equation correction for absorption –resonance escape probability – the pile equations – buckling-critical size for spherical and rectangular piles-condition for chain reaction – the four-factor formula – Classification of reactors – thermal neutron and fast breeder reactors.	15
III	**Beta Decay:** Introduction, beta spectroscopy, classification of beta transition on the basis of ft values, selection rules and shapes of beta spectra. Universal fermi interaction. The neutrino in beta decay-inverse beta decay processes- detection of neutrino; Cowan and Reins experiment, determination of neutrino mass, different types of neutrinos, Symmetry breaking in beta decay-parity operation: relevance of pseudoscalar quantities. The Wu-Ambler experiment and fall of parity conservation. Discovery of W and Z bosons. Double beta decay, beta delayed nucleon emission. Elementary theory of K-electron capture.	15
IV	**Gamma decay:** Review of gamma decay, qualitative discussion of multiple radiation, selection rules, determination of gamma decay transition probability for single particle transition in nuclei-Weisskopf's estimates, comparison with experimental values. Elementary theory of internal conversion and discussion of experimental results. Lifetime measurements, the angular correlation for dipole-dipole transitions, gamma-gamma correlation studies. Polarization of gamma radiation.	15

Text Books:

1. Structure of the Nucleus: M. A. Preston and R.K. Bhaduri Addision – Wesley (1975).
2. Nuclear Physics Vol. II: S. N. Goshal. S. Chand and Company (2013).
3. Introductory Nuclear Physics : Kenneth S. Krane, John Wiley and sons (1998)
4. Subatomic Physics: Nuclei and Particles (Volume – II): Luc Valentin North Holland(1981).
5. Introduction to Neutron Physics: L. F. Curtis, East west press (1958).
6. Nuclear Reactor Engineering: Glasstone S and Sesonske A, CBS, Delhi, (1994).

Reference Books:

1. Theoretical Nuclear Physics: J. M. Blatt and V. F. Weisskoff, Wiley (1992).
2. Subatomic Physics (Second Edition) : Hans Frauenfelder and E.M.Henley, Prentice Hall(1991).
3. Introduction to Nuclear Physics: Herald. A. Enge, Addison-Wesley (1983).
4. Introductory Nuclear Physics: Samuel S. M. Wong, Prentice – Hall (1996).
5. Reactor Physics: Zweifel P F, International student Edn. (McGraw Hill, 1973).

Formative Assessment for Theory	
Assessment Occasion/ Type	Marks
Internal Assessment Test 1	10
Internal Assessment Test 2	10
Total	20
Formative Assessment as per Guidelines	

Discipline Specific Elective (DSE)

Course Title: Atomic and Molecular Physics Practical – III
Course Code: A4PHY107AP

Type of Course	Theory/ Practical	Credits	Instruction Hour per Week	Total No. of Lectures/ Hours/ Semester	Duration of Exam in Hours	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSE	Practical	04	08	120	04	20	80	100

Learning Objectives:

The objective of this course is to make the students

1. Understand the analysis of given atomic and molecular wavelength data.

2. Understand the analysis given empirical data so as to validate theoretical models.
3. Understand the advanced level of principles of instrumental methods
4. Learn to take spectral measurements on a given spectrometer system, organize and analyze data.
5. Understand the concepts in quantum mechanics.

Course Outcomes:

Upon completion of this course, a student should be able to

1. Learn analysis of given atomic and molecular wavelength data by applying theoretical principles learnt by them.
2. Learn how to analyze given empirical data so as to validate theoretical models.
3. Learn advanced level of principles of instrumental methods and taking spectral
4. Measurements on a given spectrometer system, organize and analyze data.
5. Do quantum mechanical calculations of the given assignment.

Experiments:

1. Rotational analysis of (0, 0) band of BeO molecule.
2. Study of Absorption spectra on a Single Beam Spectrophotometer.
3. Study of the black body radiation.
4. Study of thermal distribution of rotational levels of diatomic molecules.
5. Analysis of Rotational Raman spectrum of N 2 O molecule.
6. Quantum mechanical assignments.

(New experiments/assignment may be added by the Dept. of Physics, KUD)

Reference Books:

1. Experimental Spectroscopy (3rd Edition) : R. A. Sawyer. Dover Publication, Inc, New York (1963).
2. Atomic Spectra and Atomic Structure (2nd Edition) – G. Herzberg. Dover Publication New York (1944)
3. Atomic Spectra – H.E. White, Mc Graw –Hill, New York (1934).
4. Principles of Lasers: Svelto. O, Plenum Press New York (1982).
5. Lab. Manuals.

6. Molecular Spectra & Molecular Structure Vol. I: G. Herzberg, D. Van Nostrand Co, New York (1950)
7. Instrumental Methods of Analysis: H. H. Willard, L. L. Merrit, J. A. Dean and F. A. Settle, J. K. Jain for CBS Publishers (1986)
8. The Identification of Molecular Spectra: R.W. B. Pears & A. G. Gaydon, Wiley, New York (1961).
9. Applied Quantum Mechanics by A.F.J. Levi, Cambridge University Press, 2003

Formative Assessment for Theory	
Assessment Occasion/ Type	Marks
Internal Assessment Test 1	20
Total	20
Formative Assessment as per Guidelines	

Discipline Specific Elective (DSE)

Course Title: Condensed Matter Physics Practical – III
Course Code: A4PHY107BP

Type of Course	Theory/ Practical	Credits	Instruction Hour per Week	Total No. of Lectures/ Hours/ Semester	Duration of Exam in Hours	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSE	Practical	04	08	120	04	20	80	100

Learning Objectives:

1. To teach some of the practical aspects of Condensed Matter Physics.
2. To teach the solving of crystal structures of other Bravais lattices.

3. To understand measurements of various parameters of materials.
4. To teach the experimental measurements of dielectric materials and solar cells.

Course Outcomes:

The specific outcomes of this course are as under:

1. Indexing of tetragonal and hexagonal patterns of materials.
2. The concept of precise lattice parameters estimation can be understood.
3. Characterization of solar cell and other electronic devices can be studied.
4. Many other parameters of dielectrics can be measured and understood.

Experiments:

1. Indexing of hexagonal systems.
2. Precise parameter determination:
    a) Extrapolation method.
    b) Cohen's method.
3. Structure determination of CdTe.
4. Universal curves for ferromagnets.
5. Determination of skin depth of metals.
6. Phase transition in ferroelectric crystals.
7. Temperature dependence of susceptibility of a paramagnetic substance.
8. Characteristics of a solar cell.
9. Defect formation energy in metals.
10. Diamagnetic susceptibility of water molecule.
11. Fermi energy of copper by resistivity method.
12. Dielectric constant of non polar liquids (benzene).
13. Dipole moment of organic molecule (acetone).
14. BH curve using integrator.

(New experiments/assignment may be added by the Dept. of Physics, KUD)

Reference Books:

1. X ray diffraction: B.D. Cullity, Addison Wesley, New York (1972).
2. X ray diffraction procedures: H.P. Klug and L.E. Alexander, John Wiley & Sons, New York.

3. Interpretation of X ray powder diffraction pattern: H.P. Lipson and H. Steeple, Macmillan, London (1968).
4. Introduction to Solid State Physics : 5th Edn C. Kittel, Wiley Eastern Ltd., Bangalore (1976)
5. Elementary Solid State Physics : M. A. Omar, Addison Wesley Pvt. Ltd., New Delhi (2000)
6. Introduction to magnetochemistry: A. Earnshaw, Academic press, London (1968).
7. Solid State Physics : A. J. Dekker, Macmillan India Ltd., Bangalore (1981).
8. Solid State Physics : N. W. Aschroft and A. D. Mermin, Saunders College Publishing New York (1976).

Formative Assessment for Theory	
Assessment Occasion/ Type	Marks
Internal Assessment Test 1	20
Total	20
Formative Assessment as per Guidelines	

Discipline Specific Elective (DSE)

Course Title: Electronics and Communication Practical – III
Course Code: A4PHY107CP

Type of Course	Theory/ Practical	Credits	Instruction Hour per Week	Total No. of Lectures/ Hours/ Semester	Duration of Exam in Hours	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSE	Practical	04	08	120	04	20	80	100

Learning Objectives:

1. Implement 8085 microprocessor interfacing with stepper motors, ADC, and DAC circuits.
2. Execute programming tasks involving mathematical operations, data transfer, and sorting in 8085.

3. Understand code conversion methods, interrupts, subroutines, and modern communication systems.

Course Outcomes:

Upon completion of this course, the students will be able to-

1. Implement 8085 microprocessor interfacing – stepper motor interface
2. Cary out ADC and DAC circuit interfacing.
3. Implement 8085 Programming – mathematical operations, block transfer and sorting of 8-bit and 16-bit data.
4. Understand the use of code conversion methods.
5. Study 8085 interrupts and subroutines.

Experiments:

(8085 Programming and Interfacing)

1. Stepper motor interface.
2. ADC and DAC circuit interfacing.
3. Mathematical operations, with 16-bit data, block transfer and sorting of 8-bit data.
4. Code conversion methods and 8085 Interrupts and subroutines.

(Digital Modulation Techniques).

5. Amplitude Shift Keying.
6. Frequency Shift Keying.

(New experiments/assignment may be added by the Dept. of Physics, KUD)

References Books:

1. Microprocessor Architecture, Programming, and Applications with 8085/8080 A: Ramesh S. Gaonkar, New Age International Publishers Ltd.
2. Microcomputer theory and Applications: Rafiquzzaman Mohamed, John Wiley and Sons, New York (1987).
3. Introduction to Microprocessors (3rd Edition): Aditya P. Mathur, Tata – Mc Graw – Hall Publishing Company Ltd., New Delhi (1989).
4. Modern Digital and Analog Communication, 3rd Ed., B.P. Lathi, Oxford University Press.

Formative Assessment for Theory	
Assessment Occasion/ Type	Marks
Internal Assessment Test 1	20
Total	20
Formative Assessment as per Guidelines	

Discipline Specific Elective (DSE)

Course Title: Nuclear and Particle Physics Practical – III
Course Code: A4PHY107DP

Type of Course	Theory/ Practical	Credits	Instruction Hour per Week	Total No. of Lectures/ Hours/ Semester	Duration of Exam in Hours	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSE	Practical	04	08	120	04	20	80	100

Learning objectives:

1. Understanding the various phenomenon of the detecting system.
2. Understanding the nuclear reactions using simulations techniques.
3. Understanding the detection systems using preamplifier and amplifier and counters.
4. Understanding the Performance of MCA with PC.

Course Outcomes:

The specific outcomes of this course are as under:

1. Understand the Z^2 dependence of external bremsstrahlung radiations using NaI(Tl)gamma ray spectrometer using ^{90}Sr – ^{90}Y beta source.
2. Design and construct the double coincidence circuit using transistors, study its output wave form and determine its resolving time.
3. Understand the energy spectrum of beta particles using ^{204}Tl source and determine the end point energy of beta particles from ^{204}Tl using Si(Li) detector spectrometer.

4. Determine the K shell internal conversion coefficient αK of ^{137}Ba using NaI(Tl) gamma ray spectrometer.
5. Determine the half-life of ^{40}K using GM counting system and to analyze the results.
6. Understand the Performance of the detecting systems.

Experiments:

1. Z dependence of external Bremsstrahlung.
2. Anthracene crystal beta ray spectrometer.
3. Electron capture transition energy using internal Bremsstrahlung.
4. Coincidence circuit.
5. Si(Li) beta ray spectrometer.
6. Digital to analog converter circuits.
7. Half life of 40K.
8. Gamma gamma angular correlation.
9. Nuclear reaction analysis.
10. Schmidt trigger circuit using transistors and IC 555.
11. Charge sensitive pre amplifier using LF 357.
12. Function generator using IC 741.

(New experiments/assignment may be added by the Dept. of Physics, KUD)

Reference Books:

1. Experiments in Modern Physics: A.C. Melissions, Academic Press (NY) (1966).
2. Experiments in Nuclear Science, ORTEC Application Note. ORTEC, (1971) (Available in Nuclear Physics Laboratory).
3. Practical Nucleonics: F. J. Pearson., R. R. Osborne, E & F. N. Spon Ltd., London (1960).
4. The Atomic Nucleus: R. D. Evans, tata Mc Graw Hill Pub. Comp. Ltd. (1960).
5. Nuclear Radiation Detectors: R. D. Kapoor V.S. Ramamurthy, Wiley Eastern Ltd (1986).
6. Experimental Nucleonics: E. Bleuler, G. J. Goldsmith, Rinehart & Co. Inc. (NY) (1958)
7. A manual of experiments in reactor physics: Frank A. Valente the Macmillan company (1963).
8. A practical introduction to electronic circuits: Martin Harthley Jones Cambridge University Press (1977).

9. Integrated Circuit Projects: R. M. Marston Newnes Technical Books (1978).
10. Semiconductor Projects: R. M. Marston A Newnes Technical Books (1978).
11. Linear Integrated Circuits: D. Roy Choudhary and Shail Jain, New Age International (1995).
12. Op-Amps and Linear Integrated Circuits: Ramakanth A Gayakawad, Prentice-Hall of India (1995).

Formative Assessment for Theory	
Assessment Occasion/ Type	Marks
Internal Assessment Test 1	20
Total	20
Formative Assessment as per Guidelines	

Discipline Specific Course (DSC)

Course Title: Project
Course Code: A4PHY015P

Type of Course	Theory/ Practical	Credits	Instruction Hour per Week	Total No. of Lectures/ Hours/ Semester	Duration of Exam in Hours	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	Project	06	08	180	04	30	120	150

Learning Objectives:

1. To teach the selection of suitable research problems, literature survey etc that is of scientific importance.
2. To impart research aspects through the project work in student's respective specialization.

3. To focus on specific objectives, work plan and research methodology to complete the project work.
4. To learn the skill of project report writing, communication skill and conference participation.

Course Outcomes:

1. Project helps students to search the research problem.
2. The students directly acquire experiential learning by handling physical devices, instruments, etc., while setting up an experiment or by reading in-depth assigned subject for theoretical analysis.
3. It also helps to carry out the systematic research work on individual topics with the help of research mentor.
4. Students also leans how present, prepare and if possible, to publish their findings in the projects work.

Topic(s) for the project may be selected in consultation with the project supervisor.

Reference/Text books to be recommended by the Course Teacher

A4PHY015AP: Project in Atomic and Molecular Physics

A4PHY015BP: Project in Condensed Matter Physics

A4PHY015CP: Project in Electronics & Communications

A4PHY015DP: Project in Nuclear and Particle Physics

Formative Assessment for Theory	
Assessment Occasion/ Type	Marks
Internal Presentation	30
Total	30
Formative Assessment as per Guidelines	

Theory Paper Pattern

3 Hrs | Max. Marks: 80

Note: Answer All Questions

Q1	From Unit-I	16
	OR	
Q2	From Unit-I	16
Q3	From Unit-II	16
	OR	
Q4	From Unit-II	16
Q5	From Unit-III	16
	OR	
Q6	From Unit-III	16
Q7	From Unit-IV	16
	OR	
Q8	From Unit-IV	16
Q9	Answer ***any four*** of following:	4x4 = 16
a)	These questions must be uniformly taken from all the Units (I-IV)	
b)		
c)		
d)		
e)		
f)		

Practical Marks Distribution Summative Assessment for 80 Marks

Conduct of Practical	Journal Writing	Viva-Voce	Total
60	05	15	80