Minutes of Board of studies (BOS) meeting of HAS Department held on 17th July 2017 at 11.00 AM in the conference hall in Mechanical Engg. Department

Dr. Raj Kumar, Chairman of HAS Department chaired the meeting of BOS. At the onset of the meeting, the Chairman welcomed all the experts and members of BOS.

The following members attended the meeting:

1.	Dr. Raj Kumar	Chairman
2.	Dr. Sandeep Grover (Dean of Institutions)	Ex-officio member
3.	Dr. Jitendra Sharma	Outside Expert
4.	Dr. Kuldeep Bansal	Outside Expert
5.	Dr. Anuradha Sharma	Member
6.	Dr. Divyajyoti	Member
7.	Dr. Maneesha Garg	Member
8.	Dr. Reena Garg	Member
9.	Dr. M.K. Yadav	Member
10.	Dr. Renuka Gupta	Member
11.	Ms. Bindu Mangla	Member
12.	Ms. Nisha	Member
13.	Dr. Praveen Goyal	Member
14.	Dr. Sita Ram	Member
15.	Dr. Sandeep Garg	Member
16.	Ms. Jyoti	Member

(11.1)Item no 1: To confirm the minutes of BOS meeting held on 27th April 2017

Minutes of the meeting held on 27th April 2017 were circulated to all the members. The members confirmed the minutes.

(11.2) Item no 2: To consider and approve syllabi of various B.Tech courses taught by HAS Department

The board approves the modified syllabi of BTech, however it has been suggested that mogeneity and symmetry in the syllabus of different subjects should be maintained. All the subjects should divide the syllabus in four units.

ii Dean (F&T) has requested that the tutorials can be included in the subject of Physics and Mathematics by reducing the lectures i.e. 3 lecture and 1 tutorial. However it is informed to the house that the syllabi content has been revised considering 4 lectures. By converting the lecture to tutorial it will not be possible to cover the syllabi. Further, the house suggested that in addition to 4 lectures one tutorial may be added as 4 L and 1T. The department may discuss and decide with the dean (FET) for the possibility of the same.

(11.3) Item no 3: To consider and approve the minutes of the syllabus revision workshop for M.Sc (Physics) and B.Tech held on 12/07/17.

The board approves the syllabus of MSc. and B.Tech Physics. However the board suggests that a reference list of Open Elective and Audit courses offered by the department at this time should be attached with the syllabus of all the courses. This list of courses can be extended in future with the approval of the competent authority.

(11.4) Item no 4: To consider and approve the minutes of the syllabus revision workshop for M.Sc (Mathematics) held on 15/07/17

The board approves the syllabus of M.Sc. Mathematics with certain modifications.

(11.5) Item no 5: To consider and approve revised syllabi and scheme for M.Sc (Chemistry)

This is for the information to the board that the workshop for M.Sc. Chemistry was not conducted this time but the approval for the Audit course and Open Elective courses were taken by the experts those were in the previous workshop of syllabus revision for chemistry.

The experts pointed out that the guidelines for the project work in the fourth semester of the MSc. chemistry must be included in the syllabus booklet.

The board approves the syllabus of M.Sc. Chemistry with certain modifications.

(11.6) Item no 6: To consider and approve the minutes of the syllabus revision workshop for M.Sc (Environmental Sciences) held on 11/07/17.

The experts pointed out Basics of Microbiology must be included as a core course in the scheme of M.Sc. Environmental Sciences.

The board approves the syllabus of M.Sc. Environmental Sciences with certain modifications.

The experts again pointed out that the homogeneity in the internal and external marks of all the MSc. schemes should be maintained.

(11.7) Item no 7: To consider and approve the minutes of the syllabus revision workshop for M.A (Journalism and Mass Communication) held on 13/07/17

Dr. F.B. Khan pointed out that the experts for the workshop should be related to the subject and must be teaching in the University so that good inputs in the syllabus can be made by them. The expert also pointed out that English journalism as an subject must be included in the M.A.

The board approves the syllabus of M.A (Journalism and Mass Communication) with certain modifications.

The board proposed that the total contact hours in each PG course should be between 32 and 36.

The ordinance of MSc. should also be revised as per new guidelines and modification in syllabi and scheme.

(11.8) Item no 8: To consider and approve the minutes of the syllabus workshop for B.Sc (Physics Hons.) held on 13/07/17

The board approves the syllabus of B.Sc (Physics Hons.) with minor modifications.

The need of ordinance for BSc. and three year graduation courses was also felt. The house suggested that the department may frame the ordinance and implement with the approval of competent authority.

(29)

(11.9) **Item no 9: To ratify the seat created for PhD in Chemistry and syllabus for PhD Entrance test in Chemistry.**

The board noted the matter and suggested to be put up in the Academic Council.

(11.10) Item no 10: Any other item with the permission of the chair

To revise the scheme of Btech: It is suggested that a committee to consider the change in the credits of Chemistry, English, EVS should be formulated. This committee should also consider the possibility for Mathematics III program in all the branches of Engineering in 3rd semester.

Dr. Sandeep Garg | Dr. Sita Ram | Dr. Praveen Goyal | Ms. Nisha

Ms. Bindu Mangla | Dr. Renuka Gupta | Dr. M.K. Yadav | Dr. Reena Garg 18/7/17

Dr. Maneesha Garg 18/7/17 | Dr. Divyajyoti 18/7/17 | Dr. Anuradha Sharma 18/7/17 | Ms. Jyoti 18/7/17

Dr. Kuldeep Bansal | Dr. Jitendra Sharma | Dr. Sandeep Grover 18/7/17

Dr. Raj Kumar

NEW COURSES INTRODUCED

M.Sc Physics

(BOS dated 17th July, 2017)

S.No.	Department	Program Name	Name of the Course	Course Code
1.	Physics	M.Sc. Physics	Mathematical Physics	PHL 101
2.	Physics	M.Sc. Physics	Classical Mechanics	PHL 102
3.	Physics	M.Sc. Physics	Quantum Mechanics-I	PHL 103
4.	Physics	M.Sc. Physics	Electronic Devices and IC Technology	PHL 104
5.	Physics	M.Sc. Physics	Electronics Laboratory-I	PHP 105
6.	Physics	M.Sc. Physics	Seminar	PHP 106
7.	Physics	M.Sc. Physics	Atomic and Molecular Physics	PHL 201
8.	Physics	M.Sc. Physics	Nuclear and Particle Physics	PHL 202
9.	Physics	M.Sc. Physics	Condensed Matter Physics	PHL 203
10.	Physics	M.Sc. Physics	Electrodynamics and Plasma Physics	PHL 204
11.	Physics	M.Sc. Physics	Physics Laboratory-I	PHP 205
12.	Physics	M.Sc. Physics	Seminar	PHP 206
13.	Physics	M.Sc. Physics	Advanced Quantum Mechanics	PHL 301
14.	Physics	M.Sc. Physics	Statistical Mechanics	PHL 302
15.	Physics	M.Sc. Physics	Laser Technology	PHL 303
16.	Physics	M.Sc. Physics	Microprocessor	PHL 304
17.	Physics	M.Sc. Physics	Electronics Lab-II	PHP 305
18.	Physics	M.Sc. Physics	Seminar	PHP 306
19.	Physics	M.Sc. Physics	Physics and our world	OPHL-306A

20.	Physics	M.Sc. Physics	Introduction to Astrophysics and cosmology	OPHL-305A
21.	Physics	M.Sc. Physics	Photonics	PHL401A
22.	Physics	M.Sc. Physics	Radiation Physics	PHL401B
23.	Physics	M.Sc. Physics	Electronic Communication System	PHL 402A
24.	Physics	M.Sc. Physics	Electronic Devices and Communication	PHL 402B
25.	Physics	M.Sc. Physics	Nano Science and Technology	PHL 403A
26.	Physics	M.Sc. Physics	Computational Physics	PHL 403B
27.	Physics	M.Sc. Physics	Material Science	PHL 404A
28.	Physics	M.Sc. Physics	Smart Materials	PHL 404B
29.	Physics	M.Sc. Physics	Dissertation	PHL 405

NEW COURSES INTRODUCED

B.Sc Hon. Physics (BOS dated 17th July, 2017)

Department name	Program name	Name of the new Course	Course Code
Physics	B.Sc Physics Hons.	Mathematical Physics-I	BPH 101
Physics	B.Sc Physics Hons.	Mechanics	BPH 102
Physics	B.Sc Physics Hons.	Mathematical Physics-I Lab	BPH 103
Physics	B.Sc Physics Hons.	Mechanics Lab	BPH 104
Physics	B.Sc Physics Hons.	English	BENG 101
Physics	B.Sc Physics Hons.	Calculus	OMTH 101
Physics	B.Sc Physics Hons.	Electronic circuit & PCB Designing	OELC 101
Physics	B.Sc Physics Hons.	Introduction to Programming	OCSC 101
Physics	B.Sc Physics Hons.	Inorganic Chemistry	OCHE 101
Physics	B.Sc Physics Hons.	Electronic circuit & PCB Designing Lab	OELC 102
Physics	B.Sc Physics Hons.	Introduction to Programming Lab	OCSC 102 I
Physics	B.Sc Physics Hons.	Inorganic Chemistry Lab	OCHE 102
Physics	B.Sc Physics Hons.	MOOC	XXX
Physics	B.Sc Physics Hons.	Electricity & Magnetism	BPH 201
Physics	B.Sc Physics Hons.	Waves & Optics	BPH 202
Physics	B.Sc Physics Hons.	Electricity & Magnetism Lab	BPH 203
Physics	B.Sc Physics Hons.	Waves & Optics Lab	BPH 204
Physics	B.Sc Physics Hons.	Environmental Science	BEVS 101
Physics	B.Sc Physics Hons.	Linear Algebra	OMTH 201
Physics	B.Sc Physics Hons.	Instrumentation	OELC 201
Physics	B.Sc Physics Hons.	Introduction to Database System	OCSC 201
Physics	B.Sc Physics Hons.	Physical Chemistry	OCHE 201
Physics	B.Sc Physics Hons.	Instrumentation Lab	OELC 202
Physics	B.Sc Physics Hons.	Introduction to Database System Lab	OCSC 202
Physics	B.Sc Physics Hons.	Physical Chemistry Lab	OCHE 202
Physics	B.Sc Physics Hons.	MOOC	XXX
Physics	B.Sc Physics Hons.	Audit Course (French offered by CS department)	AUD-03
Physics	B.Sc Physics Hons.	Mathematical Physics-II	BPH 301
Physics	B.Sc Physics Hons.	Thermal Physics	BPH 302

Physics	B.Sc Physics Hons.	Analog Systems & Applications	BPH 303
Physics	B.Sc Physics Hons.	Mathematical Physics-II Lab	BPH 304
Physics	B.Sc Physics Hons.	Thermal Physics Lab	BPH 305
Physics	B.Sc Physics Hons.	Analog Systems & Applications Lab	BPH 306
Physics	B.Sc Physics Hons.	Computational Physics Skills	SECP 01
Physics	B.Sc Physics Hons.	Electrical Circuits & Network Skills	SECP 02
Physics	B.Sc Physics Hons.	Basic Instrumentation Skills	SECP 03
Physics	B.Sc Physics Hons.	Computational Physics Skills Lab	SECP 04
Physics	B.Sc Physics Hons.	Electrical Circuits & Network Skills Lab	SECP 05
Physics	B.Sc Physics Hons.	Basic Instrumentation Skills Lab	SECP 06
Physics	B.Sc Physics Hons.	Differential Equations	OMTH 301
Physics	B.Sc Physics Hons.	Communication Systems	OELC 301
Physics	B.Sc Physics Hons.	Computer Networks & Internet Technology	OCSC 301
Physics	B.Sc Physics Hons.	Organic Chemistry	OCHE 301
Physics	B.Sc Physics Hons.	Communication Systems Lab	OELC 302
Physics	B.Sc Physics Hons.	Computer Networks & Internet Technology Lab	OCSC 302
Physics	B.Sc Physics Hons.	Organic Chemistry Lab	OCHE 302
Physics	B.Sc Physics Hons.	MOOC	XXX
Physics	B.Sc Physics Hons.	Mathematical Physics-III	BPH 401
Physics	B.Sc Physics Hons.	Elements of Modern Physics	BPH 402
Physics	B.Sc Physics Hons.	Digital Systems & Application	BPH 403
Physics	B.Sc Physics Hons.	Mathematical Physics-III Lab	BPH 404
Physics	B.Sc Physics Hons.	Elements of Modern Physics Lab	BPH 405
Physics	B.Sc Physics Hons.	Digital Systems & Applications Lab	BPH 406
Physics	B.Sc Physics Hons.	Computational Physics Skills	SECP 01
Physics	B.Sc Physics Hons.	Electrical Circuits & Network Skills	SECP 02
Physics	B.Sc Physics Hons.	Basic Instrumentation Skills	SECP 03
Physics	B.Sc Physics Hons.	Computational Physics Skills Lab	SECP 04
Physics	B.Sc Physics Hons.	Electrical Circuits & Network Skills Lab	SECP 05
Physics	B.Sc Physics Hons.	Basic Instrumentation Skills Lab	SECP 06
Physics	B.Sc Physics Hons.	Numerical Methods	OMTH 401
Physics	B.Sc Physics Hons.	Microprocessor & Microcontroller Systems	OELC 401
Physics	B.Sc Physics Hons.	Information Security	OCSC 401
Physics	B.Sc Physics Hons.	Spectroscopy	OCHE 401
Physics	B.Sc Physics Hons.	Microprocessor & Microcontroller Systems Lab	OELC 402

Physics	B.Sc Physics Hons.	Information Security Lab	OCSC 402
Physics	B.Sc Physics Hons.	Spectroscopy Lab	OCHE 402
Physics	B.Sc Physics Hons.	MOOC	XXX
Physics	B.Sc Physics Hons.	Quantum Mechanics & Applications	BPH 501
Physics	B.Sc Physics Hons.	Solid State Physics	BPH 502
Physics	B.Sc Physics Hons.	Quantum Mechanics & Applications Lab	BPH 503
Physics	B.Sc Physics Hons.	Solid State Physics Lab	BPH 504
Physics	B.Sc Physics Hons.	Atomic & Molecular Physic	DECP 501
Physics	B.Sc Physics Hons.	Experimental Techniques	DECP 502
Physics	B.Sc Physics Hons.	Linear Algebra & Tensor Analysis	DECP 503
Physics	B.Sc Physics Hons.	Experimental Techniques Lab	DECP 504
Physics	B.Sc Physics Hons.	Biological & Medical Physics	DECP 505
Physics	B.Sc Physics Hons.	MOOC	XXX
Physics	B.Sc Physics Hons.	Electromagnetic Theory	BPH 601
Physics	B.Sc Physics Hons.	Statistical Mechanics	BPH 602
Physics	B.Sc Physics Hons.	Electromagnetic Theory Lab	BPH 603
Physics	B.Sc Physics Hons.	Statistical Mechanics Lab	BPH 604
Physics	B.Sc Physics Hons.	Nuclear & Particle Physics	DECP 601
Physics	B.Sc Physics Hons.	Nano Materials & Applications	DECP 602
Physics	B.Sc Physics Hons.	Physics of Devices & Communication	DECP 603
Physics	B.Sc Physics Hons.	Nano Materials & Applications Lab	DECP 604
Physics	B.Sc Physics Hons.	Physics of Devices & Communication Lab	DECP 605
Physics	B.Sc Physics Hons.	Classical Dynamics	DECP 606

FACULTY OF HUMANITIES AND SCIENCES

DEPARTMENT OF PHYSICS

M.Sc. (Physics)

ACADEMIC SESSION 2017-2018

YMCA UNIVERSITY OF SCIENCE AND TECHNOLOGY

YMCA UNIVERSITY OF SCIENCE AND TECHNOLOGY

VISION

YMCA University of Science and Technology aspires to be a nationally and internationally acclaimed leader in technical and higher education in all spheres which transforms the life of students through integration of teaching, research and character building.

MISSION

- To contribute to the development of science and technology by synthesizing teaching, research and creative activities.
- To provide an enviable research environment and state-of-the art technological exposure to its
  Scholars.
- To develop human potential to its fullest extent and make them emerge as world class leaders in their professions and enthuse them towards their social responsibilities

HUMANITIES AND SCIENCES DEPARTMENT

VISION

A department that can effectively harness its multidisciplinary strengths to create an academically stimulating atmosphere; evolving into a well-integrated system that synergizes the efforts of its competent faculty towards imparting intellectual confidence that aids comprehension and complements the spirit of inquiry.

MISSION

- To create well-rounded individuals ready to comprehend scientific and technical challenges offered in the area of specialization.
- To counsel the students so that the roadmap becomes clearer to them and they have the zest to turn the blueprint of their careers into a material reality.
- To encourage critical thinking and develop their research acumen by aiding the nascent spirit for scientific exploration.
- Help them take economic, social, legal and political considerations when visualizing the role of technology in improving quality of life.
- To infuse intellectual audacity that makes them take bold initiatives to venture into alternative methods and modes to achieve technological breakthroughs.

M.Sc. Physics

The M.Sc. program in Physics aims to provide students with a sound knowledge of the principles of Physics which form a thorough basis for careers in Physics and related fields. It also aims to enable students to develop insights into the techniques used in current fields and allow an in-depth experience of a particular specialized research area. In addition, the M.Sc Program is meant to develop professional skills in students that play a meaningful role in industrial and academic life and give students the experience of teamwork, a chance to develop presentation skills and learn to work to deadlines. The M.Sc. program includes a number of lecture courses and laboratory courses both relevant to the discipline and forward-looking with respect to recent developments and state-of-the-art achievements.

PROGRAM OBJECTIVE

The objective of the program is

- To prepare students for careers in University teaching and research.
- To develop thorough and in-depth knowledge of various courses in Physics such as Electronics, Quantum Mechanics, Nuclear Physics, and Condensed matter Physics, Laser, Nanotechnology, etc.
- To inculcate strong student competencies in Physics and its applications in a technology-rich, interactive environment.
- To develop strong student skills in research, analysis and interpretation of complex information.
- To prepare the students to successfully compete for employment in Research labs and teaching and to offer a wide range of experience in research methods, data analysis to meet industrial needs.

PROGRAM OUTCOMES

After completion of the program, the students will:

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

YMCA UNIVERSITY OF SCIENCE AND TECHNOLOGY, FARIDABAD
DEPARTMENT OF HUMANITIES AND SCIENCES

STRUCTURE AND SYLLABI OF M.SC. PHYSICS (4 SEMESTER COURSE)

SEMESTER I

Subject Code	Title	L	T	P	Internal Assessment	End-semester Examination	Total	Credits	Category Code
PHL 101	Mathematical Physics	4	0	0	25	75	100	4	DCC
PHL 102	Classical Mechanics	4	0	0	25	75	100	4	DCC
PHL 103	Quantum Mechanics-I	4	0	0	25	75	100	4	DCC
PHL 104	Electronic Devices and IC Technology	4	0	0	25	75	100	4	DCC
PHP 105	Electronics Laboratory-I	0	0	20	30	70	100	8	DCC
PHP 106	Seminar	2	0	0	50		50	0	DCC
XXX	MOOC**								MOOC
Total Marks							**550**	**24**	

* DCC – Discipline Core Course; MOOC – Massive Open Online Course
**The students have to pass at least one mandatory MOOC course with 4-6 credits (12-16 weeks) from the list given list on the Swayam portal or the list given by the Department/ University from 1st semester to 3rd semester as notified by the University. (Instructions to students overleaf)
L – Lecture; P - Practical; Tutorial

Instructions to the students regarding MOOC

1. Two types of courses will be circulated: branch specific and general courses from the website https://swayam.gov.in in the month of June and November every year for the forthcoming semester.
2. The department coordinators will be the course coordinators of their respective departments.
3. Every student has to pass a selected MOOC course within the duration ass specified below:

Programme	**Duration**
B. Tech.	Sem. I to Sem. VII
M.Sc./M.Tech./M.A./MBA	Sem. I to Sem. III
B.Sc./MCA	Sem. I to Sem. V

The passing of a MOOC course is mandatory for the fulfillment of the award of the degree of concerned programme.

4. A student has to register for the course for which he is interested and eligible which is approved by the department with the help of course coordinator of the concerned department.
5. A student may register in the MOOC course of any programme. However, a UG student will register only in UG MOOC courses and a PG student will register in only PG MOOC courses.
6. The students must read all the instructions for the selected course on the website, get updated with all key dates of the concerned course and must inform his/her progress to their course coordinator.
7. The student has to pass the exam (online or pen-paper mode as the case may be) with at least 40% marks.
8. The students should note that there will be a weightage of Assessment/quiz etc. and final examination appropriately as mentioned in the instructions for a particular course.
9. A student must claim the credits earned in the MOOC course in his/her marksheet in the examination branch by forwarding his/her application through course coordinator and chairperson.

SEMESTER II

Subject Code	Title	L	T	P	Internal Assessment	End-semester Examination	Total	Credits	Category Code
PHL 201	Atomic and Molecular Physics	4	0	0	25	75	100	4	DCC
PHL 202	Nuclear and Particle Physics	4	0	0	25	75	100	4	DCC
PHL 203	Condensed Matter Physics	4	0	0	25	75	100	4	DCC
PHL 204	Electrodynamics and Plasma Physics	4	0	0	25	75	100	4	DCC
PHP 205	Physics Laboratory-I	0	0	20	30	70	100	8	DCC
PHP 206	Seminar	2	0	0	50		50	0	DCC
XXX	Audit Course*	2	0	0	25	75	100	0	AUD
Total Marks							**650**	**24**	

- DCC – Discipline Core Course; AUD-Audit Course; L – Lecture; P – Practical: T-Tutorial
- *provided by the Department/ University.

SEMESTER III

Subject Code	Title	L	T	P	Internal Assessment	End-semester Examination	Total	Credits	Category Code
PHL 301	Advanced Quantum Mechanics	4	0	0	25	75	100	4	DCC
PHL 302	Statistical Mechanics	4	0	0	25	75	100	4	DCC
PHL 303	Laser Technology	4	0	0	25	75	100	4	DCC
PHL 304	Microprocessor	4	0	0	25	75	100	4	DCC
PHP 305	Electronics Lab-II	0	0	20	30	70	100	8	DCC
PHP 306	Seminar	2	0		50		50	0	DCC
XXX	Open Elective*	3	0	0	25	75	100	3	OEC
Total Marks							**650**	**27**	

- DCC – Discipline Core Course; OEC – Open Elective Course; L – Lecture; P – Practical
- *The department offers two open elective courses which can be taken by students of other departments.

SEMESTER IV

Subject Code	Title	L	T	P	Internal Assessment	End-semester Examination	Total	Credits	Category Code
PHL401A	Photonics	4	0	0	25	75	100	4	DEC
PHL401B	Radiation Physics								
PHL 402A	Electronic Communication System	4	0	0	25	75	100	4	DEC
PHL 402B	Electronic Devices and Communication								
PHL 403A	Nano Science and Technology	4	0	0	25	75	100	4	DEC
PHL 403B	Computational Physics								
PHL 404A	Material Science	4	0	0	25	75	100	4	DEC
PHL 404B	Smart Materials								
PHL 405	Dissertation	2	0	0	30	70	100	8	DCC
Total Marks							**500**	**24**	

- DCC – Discipline Core Course; DEC – Discipline Elective Course; L – Lecture; P - Practical
- Students have to select one DEC paper from each group or the course offered by the Department.
- Elective Courses can be offered subject to availability of requisite resources/ faculty in the University/Department.

Grading Scheme

*Percentage	Grade	Grade Points	Category
95-100	O	10	Outstanding
85-95	A+	9	Excellent
75-85	A	8	Very Good
65-75	B+	7	Good
55-65	B	6	Above average
45-55	C	5	Average
40-45	P	4	Pass
<	F	0	Fail
	AD	0	Absent

***Lower limit included, upper limit excluded**

The multiplication factor for CGPA is 10

1. Automatic Rounding
2. Average difference between actual percentage and CGPA percentage ± 2.5%
3. Worst case difference between actual percentage and CGPA percentage ± 5% if somebody in all the 8 semesters in all the exams (around 75 in numbers) consistently scores at the bottom of the range, say 55 of 55-65 which is a very remote possibility.

M.Sc. PHYSICS I SEM

PHL 101

SUBJECT NAME: MATHEMATICAL PHYSICS

NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

This course has been developed to introduce students to some topics of mathematical Physics which are directly relevant in different papers of Physics course. It includes functions of a complex variable and calculus, special functions, elements of group theory, Integral Transforms.

Unit I: Theory of functions of a Complex variable (12hrs)

Function of a Complex variable, Exponential functions, Logarithmic functions, Analyticity and Cauchy condition, Cauchy-Riemann equations, necessary and sufficient conditions for a function to be analytic, Harmonic functions, Cauchy's Integral Theorem, Cauchy's Integral formula, Taylor's Series and Laurent's series and expansion, Zeroes and Singular Points, Multi valued functions, Residues, Cauchy's Residue Theorem, Jordon's Lemma, Evaluation of real definite integrals.

Unit II: Special Functions (12 hrs.)

Bessel Functions: Bessel functions of the first kind $J_n(x)$, Generating function, Recurrence relations, Expansion of $J_n(x)$ when n is half an odd integer, Integral representation; Legendre Polynomials $P_n(x)$: Generating function, Recurrence relations and special properties, Rodrigues' formula, Orthogonality of $P_n(x)$; Associated Legendre polynomials and their orthogonality, Hermite and Laguerre Polynomials: generating function & recurrence relations only.

Unit III: Matrices and Group Theory (12 hrs.)

Matrices: Orthogonal, Unitary and Hermitian Matrices with examples, Independent elements of orthogonal and unitary matrices of order 2, Matrix diagonalization, eigenvalues and eigenvectors; Fundamentals of Group theory: Definition of a group and illustrative examples, Group multiplication table, rearrangement theorem, cyclic groups.

Unit IV: Integral Transforms (12hrs)

Fourier Integral theorem, Fourier Sine, Cosine and Complex transforms with examples, Properties of Fourier transform, Fourier transforms of Derivatives, Parseval's theorem,

Convolution theorem, Fourier transform of Integrals.
Laplace Transforms, Transforms of some Elementary Functions, Properties of Laplace transform, Transform of Derivatives, Transform of Integrals, Convolution theorem and its applications, Inverse Laplace Transform by partial fractions method

COURSE OUTCOMES

After completion of the course, students will have would be able

- To solve real definite integrals in theoretical Physics.
- To use special functions for solving Quantum Mechanical Problems.
- To use matrices for solving linear algebraic equations and to use group theory for understanding of crystallography.
- To use integral transforms for analysis of wave mechanics.

REFERENCE BOOKS:

1. Arfken: Numerical methods for Physicists
3. Ghatak: Mathematical Physics
4. H.K. Dass: Mathematical Physics
5. M. R. Spiegel: Schaum's Outlines Complex Variables
6. M. Tinkam: Group theory and Quantum Mechanics
7. B. Baumslag, B. Chandler: Schaum's Outlines Group Theory

M.Sc. PHYSICS I SEM

PHL 102

SUBJECT NAME: CLASSICAL MECHANICS

NO OF CREDITS:4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

The course aims to develop an understanding of Lagrangian and Hamiltonian which allow simplified treatments of many problems in classical mechanics. The course aims to provide the foundation for the modern understating of dynamics.

Unit I: Lagrangian and Hamiltonian formulations (12 hrs.)
Hamilton's principle, Derivation of Lagrange's equations from Hamilton's principle, Principle of Least Action and its applications, Canonical Transformation; The Hamiltonian Formalism: Canonical formalism, Hamiltonian equations of motion, The physical significance of the Hamiltonian, Cyclic coordinates, Routhian procedure and equations,

Unit II: Poisson bracket and theory of small oscillations (12 hrs.)
Poisson bracket, Poisson theorem, Poisson bracket and canonical transformation, Jacobi identity and its derivation, Lagrange bracket and its properties, the relationship between Poisson and Lagrange brackets and its derivation, the angular momenta and Poisson bracket, Liouville's theorem and its applications; Theory of small oscillations: Formulation of the problem, Eigen value equation and the principle axis transformation, frequencies of free vibrations and normal coordinates, free vibrations of a linear triatomic molecule, beyond small oscillations; the damped driven pendulum.

Unit III: Two-body central force problem and H-J theory (12 hrs.)
Two body central force problem: Reduction to the equivalent one body problem, the equation of motion and first integrals, classification of orbits, the Virial theorem, the differential equation for the orbit, integrable power law in time in the Kepler's problem, H-J Theory: H-J equation and their solutions.

Unit IV: Introductory non-linear dynamics (12 hrs.)
Classical Chaos: Periodic motion, phase portraits for conservative systems, attractors, classification and stability of equilibrium points, stability analysis of cubic anharmonic oscillator and undamped pendulum, chaotic trajectories and Liapunov exponent, Poincare Map, Henon-Hiels Hamiltonian, driven-damped harmonic oscillator

COURSE OUTCOME

On successful completion of this course, students should be able to:

- Understand the Lagrangian and Hamiltonian formalisms so that they can apply these methods to solve real world problems.
- Understand the theory of small oscillations and concept of Poisson bracket.
- Understand the Two-body central force problem and H-J theory.
- Understand the multi-disciplinary topic 'Chaos' which will enable the students to learn non-linear dynamics.

REFERENCE BOOKS:

1. Classical Mechanics (3rd ed., 2002) by H. Goldstein, C. Poole and J. Safko

2. Classical Mechanics of particles and rigid bodies by K. C. Gupta

3. Chaos and Integrability in nonlinear dynamics: An introduction (1989) by Michael Tabor

4. Nonlinear dynamics: Integrability, Chaos and patterns (2003) by M. Lakshmanan and S. Rajaseka

M.Sc. PHYSICS I SEM

PHL 103

SUBJECT NAME: QUANTUM MECHANICS

NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

This course aims at providing an elementary introduction to the basic principles of (non-relativistic) Quantum Mechanics, and its wave-mechanical and matrix-mechanics formulations. This course would enable students to comprehend the basic structure of Quantum Mechanics and to use it in different branches of Physics like Atomic and Molecular Physics, Nuclear Physics, Condensed Matter Physics etc.

UNIT-I: General formalism of Quantum Mechanics (12hrs)

Overview of Linear Vector Space, Basis, operators, Interpretative postulates of quantum mechanics, Dirac Notations of Bra and Ket, Matrix Representation of Observables and States, Determination of Eigen values and Eigen functions of Observables, orthogonality, completeness. Hilbert space representation, Matrix Representations, Change of Representation and Unitary Transformation, Co-ordinate and Momentum Representations, Equations of Motion in Schrodinger and Heisenberg Pictures.

UNIT-II: Theory of Angular Momentum (12hrs)

Orbital angular momentum operator L, Cartesian and spherical polar co-ordinate representation, Commutation Rules for Angular Momentum, Eigen values and Eigen functions of L^2 and L_z General angular momentum operator J Eigen values and Eigen functions of J^2 and J_z Matrix Representation of Angular Momentum Operator, Spin angular momentum, Wavefunction including spin(Spinor), spin one half: spin Pauli Spin Matrices.

UNIT-III: Scattering (12hrs)

Differential and Total Cross-Sections, Laboratory and center of mass frame, Theory of Partial Wave and Calculation of Phase Shifts in Simple Cases, Integral Form of Scattering Equation, Born Approximation, Its Validity and Simple Applications.

UNIT-IV: Perturbation Theory (12hrs)
Perturbation Theory of Non-degenerate Systems with first order correction, Application to Normal He Atom, Zeeman Effect, Perturbation Theory for Degenerate Systems, First order correction, Stark Effect in H-Atom, Time Dependent Perturbation Theory, Fermi's Golden Rule and Example of Harmonic Perturbations.

COURSE OUTCOME

On successful completion of this course, students should be able to:

- Understand the general formalism of Quantum Mechanics.
- Understand the theory of Angular Momentum and its application in quantum mechanics.
- Understand the theory of scattering and calculation of Phase Shifts in Simple Cases.
- Apply the perturbation theory for time independent and time dependent cases.

REFERENCE BOOKS:

1. Ghatak & Lokanathan: Quantum Mechanics
2. Schiff: Quantum Mechanics
3. Dirac: Principles of Quantum Mechanics
4. Sakurai: Modern Quantum Mechanics
5. Das and Melissinos: Quantum Mechanics - A Modern Introduction

M.Sc. PHYSICS I SEM

PHL 104
SUBJECT NAME: ELECTRONIC DEVICES AND IC TECHNOLOGY
NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

This course is designed to understand the basics of transistors and their applications as amplifiers. Designing of simple circuits like amplifiers (inverting and non inverting), comparators, adders, integrator and differentiator using op-amps will be discussed.

The second part of the course will give an introduction to digital electronics in which the different building blocks in digital electronics using logic gates and implementation of simple logic function using basic universal gates will be covered.

Unit I: Semiconductor Devices and Fabrication of ICs (12 hrs)

Metal/Semiconductor Contact, MOS Junction (Accumulation, Depletion and Inversion), Interface States and Their Effects, Fabrication of ICs, monolithic Integrated Circuit Technology, planar process, Fabrication of Bipolar Transistor, Resistor, capacitor, FET.

Unit II: Bipolar junction transistor and Field effect transistor (12 hrs)

PNP and NPN transistors, basic transistor action, emitter efficiency, base transport factor, current gain, input and output characteristics of CB, CE and CC configurations and amplifiers, Construction of JFET, MOSFET, Idea of channel formation, pinch off and saturation voltage, current voltage output characteristics.

Unit III: Op-Amp (IC-741) and 555 Timer (12 hrs)

DC coupled amplifiers, common mode rejection ratio, Block Diagram of Op-Amp, Input offset voltage, Input bias current, Slew Rate, Frequency Response and Compensation, Feedback in amplifiers, Inverting and non inverting amplifiers, Linear application of op amp: summing, difference, Integration, differentiator, Non-Linear application of op amp: Comparator, Zero crossing detector, Schmitt trigger

555 Timer: 555 Timer – Description and block diagram - Monostable operation, Astable operation

Unit IV: Digital Circuits and Systems (12 hrs)

Binary Adders, full adder and half adder, serial and parallel adders, binary subtractor, Digital comparator, BCD to decimal Decoder, multiplexer, Demultiplexer, Memory Concept, RAM, ROM, PROM, EPROM, EEPROM, Flip-Flops: SR, JK, Master Slave, D Type, T Type, Shift register, Asynchronous counter, Up-Down counter, Divided by N counter.

COURSE OUTCOMES

On successful completion of this course, students should be able to:

- Understand various semiconductor devices the fabrication of ICs
- Understand the working and characteristics of BJT and FET.
- Understand the working and applications of Op-Amp (IC-741) and 555 Timer.
- Understand the Digital Circuits and Systems

REFERENCE BOOKS:

1. Millman and Halkias: Integrated Electronics
2. Gayakwad: OP-AMPS and Linear Integrated Circuits
3. Jacob Millman and Arvin Grabel: Microelectronics

MSc PHYSICS I SEM

PHP 105

ELECTRONICS LAB I

NO OF CREDITS: 8

		SESSIONAL:	30
L	P	THEORY EXAM:	70
0	16	TOTAL:	100

COURSE OBJECTIVE

This course is designed to provide students with fundamental concepts of Electronic Circuits for lab experience such as study of operation of Oscillators and Waveform generators like multivibrators and Schmitt trigger. This lab will also give students the preview of the various applications of op-amp and flip flops.

Students assigned the electronic laboratory work will perform at least 8 experiments of the following

1. To design full adder and full subtractor and verify its truth table using logic gates.
2. To design JK Flip flop and realize up down counter using it.
3. To study negative feedback in op amp (summing/difference.
4. To construct an astable multivibrator using transistor and to determine the frequency of oscillation.
5. To design basic comparator and Zero crossing detector using 741 op amp.
6. Application of op-amp as an integrator/differentiator amplifier.
7. To design an astable and monostable multivibrator using 555 timer.
8. To study the common emitter transistor using npn transistor.
9. To study Zener diode as a voltage regulator.
10. To design 4 bit shift register using JK Flip flop.
11. To design multiplexer/demultiplexer.

COURSE OUTCOMES

- Verify the working of diodes, transistors and their applications.
- Build a common emitter/base/collector amplifier and measure its voltage gain.
- Understand the use of CRO.

• Explore the operation and advantages of operational amplifiers.
• Learn to design different types of filters and apply the same to oscillators and amplifiers.
• Exploring the circuitry which converts an analog signal to digital signal.

M.Sc. PHYSICS II SEM
PHL 201
SUBJECT NAME: ATOMIC AND MOLECULAR PHYSICS
NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

To understand the fundamentals of atomic and molecular physics. To provide a coherent and concise coverage of traditional atomic and molecular physics.

UNIT-1: Atomic Physics (12hrs)

Fine structure of hydrogen atoms-mass correction, Spin orbit term, Darwin term, Intensity of fine structure lines, ground state of two electron atoms-perturbation theory and variation method. Many electron atoms- LS and jj coupling schemes, Lande interval rule. Terms for equivalent & non-equivalent electron atom. Space Quantization: stern Gerlach experiment, normal & anomalous Zeeman effect, Stark effect, Paschen-Back effect; Intensities of spectral line: General selection rule, Hyperfine Structure, Isotope Shifts and Nuclear Size Effects.

UNIT-II: Molecular Structure(12hrs)

Born-Oppenheimer separation for diatomic molecules, rotation, vibration and electronic structure of diatomic molecules. Description of Molecular Orbital and Electronic Configuration of Diatomic Molecules: H_2, H_2^+. Co-relation diagram for hetero-nuclear molecules.

UNIT-III: Molecular Spectra(12hrs)

Rotation, Vibration-rotation and electronic spectra of diatomic molecules. The Franck Condon Principle. Raman Spectroscopy: Introduction, pure rotational Raman Spectra, vibrational Raman spectra, Nuclear spin and intensity alternation in Raman spectra, Isotope effect and Raman spectrometer. Dissociation and pre dissociation, Dissociation energy, Rotational fine structure of electronic bands.

UNIT-IV: Resonance Spectroscopy(12hrs)

NMR: Basic principles- classical and quantum description-Bloch Equation-spin-spin and spin-lattice relaxation times-chemical shift and coupling constant- experimental methods-single and double coil methods; ESR: Basic principles, ESR Spectrometer-nuclear interaction and hyperfine structure-relaxation effects-g factor.

COURSE OUTCOME

On successful completion of this course, students should be able to:

- Understand the fundamental aspects of atomic and molecular physics.
- Understand the molecular structure.
- Carry out experimental and theoretical studies on atoms and molecules, with focus on the structure and dynamics of atoms and molecules, and
- Understand resonance spectroscopy; NMR, ESR.

REFERENCE BOOKS:

1 Concepts of Modern Physics by Arthur Beiser (McGraw-Hill Book Company, 1987).
2 Atomic spectra & atomic structure, Gerhard Hertzberg: Dover publication, New York.
3 Molecular structure & spectroscopy, G. Aruldhas; Prentice – Hall of India, New Delhi.
4 Fundamentals of molecular spectroscopy, Colin N. Banwell & Elaine M. McCash, Tata McGraw –Hill publishing company limited.
5 Introduction to Atomic spectra by H.E. White
6 Spectra of diatomic molecules by Gerhard Herzberg
7 Principles of fluorescence spectroscopy by Joseph R. Lakowicz

M.Sc. PHYSICS II SEM
PHL 202
SUBJECT NAME: NUCLEAR AND PARTICLE PHYSICS
NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

The course aims to provide students with an understanding of basic radiation interaction and detection techniques for nuclear physics, radioactive decays, nuclear reactions and elementary particle physics.

Unit I: Detectors and Accelerators (12hrs)

Interaction of Nuclear Radiations with matter; Interaction of charged Particles and of Gamma Rays with matter, Stopping power of Heavy charged particles Range and Straggling, Absorption of Gamma- Rays, the P.E effect , Compton Effect and Pair production, Nuclear detectors for high Energy Physics, Spark Chamber Cerenkov Detector, GM counter, Scintillation detector

Unit II: Nuclear Reaction (12hrs)

Liquid drop model, Shell model, Types of Nuclear Reactions, Nuclear Reaction Kinematics, Nuclear transmutations, Transmutations by alpha particles, protons, neutrons, deuterons, etc, Nuclear Cross section, Expression for Scattering and Nuclear Cross-section, Reaction Mechanism- Direct and Compound nuclear reactions, Compound Nucleus theory, Energy levels of nuclei, Continuum Theory of Nuclear Reaction, Resonance cross- sections, Breit-Wigner Dispersion Formula.

Unit III: Radioactive decay and Nuclear forces (12hrs)

Alpha particles, their charge to mass ratio, range, energy, Gamow's Theory of Alpha-Decay, Fermi's Theory of Beta-Decay, Curie's Plots; the neutrino, its detection and properties, Gamma Radiation, measurement of Gamma-Ray energy, Deuteron problem; neutron-proton and proton-proton scattering at low energies , Partial wave Analysis.

Unit IV: Particle Physics (12hrs)

Units of high energy physics, Classification of particles-fermions and bosons, Particles and antiparticles, Strange particles, Basic idea of different fundamental types of interactions with suitable examples, Quarks flavors and their quantum numbers, Quarks as constituents of Hadrons

COURSE OUTCOME

After the successful completion of the course, students would be able to:

- Describe the basic interaction mechanisms for charged particles and electromagnetic radiation and explain the working principles behind detectors and their characteristic properties with respect to energy resolution, efficiency etc.
- Understand the mechanism and kinematics of nuclear reactions.
- Describe the basic features involved in alpha and beta decays and nuclear forces
- Comprehend the fundamentals of elementary particle physics.

REFERENCE BOOKS:

1. **Preston and Bhaduri: Nuclear structure**
2. **Pal: Nuclear structure**
3. **Wong: Introductory Nuclear Physics**
4. **R.M Singru: Introduction to experimental Nuclear Physics**
5. **Tayal: Nuclear Physics**

M.Sc. PHYSICS II SEM
PHL 203
SUBJECT NAME: CONDENSED MATTER PHYSICS
NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

Our objective is to train students in the field of condensed matter physics and materials science. The concepts of lattice, crystal structure, reciprocal lattice, phonon, Fermi surface, Brillouin zone, metal and semiconductor theory and properties will be taught.

The use of more sophisticated models of electron behavior in a periodic potential, such as the tight binding model, to explain the electronic structure of materials will be done qualitatively and quantitatively.

Unit I: Symmetry and Reciprocal Lattice

crystal symmetry elements, Miller indices, Direct lattice type, fundamental type of direct lattices i.e. 2 dimensional and 3 dimensional lattice, reciprocal lattice, reciprocal lattice (sc, bcc, fcc) Bragg's law in direct and reciprocal lattice, crystal structure factor (bcc, fcc), atomic form factor, Scattering factors, Intensity of diffraction maxima, extinction due to lattice centering.

Unit II: Lattice Vibration

The concept of lattice modes of vibration, elastic vibrations of continuous media, vibration of one dimensional mono-atomic and diatomic linear lattice, particle displacement in two branches, wavelength limit of acoustic phonons, concept of phonons, inelastic scattering of photons and phonons, inelastic scattering of X rays by phonons, inelastic scattering of neutrons by phonons, electron phonon interaction, polarons, electron-electron interaction

Unit III: Electronic Properties of Solids

Electrons in periodic potential, Kronig Penny model for band theory, brillouin zone, reduced zone, effective mass, physical interpretation of effective mass, distinction between metals, semiconductors and insulators, density of state function, density of electrons in conduction band, density of holes in valence bands, Donor and acceptor impurities in n-type and p-type semiconductors, Metal-Semiconductor junctions.

UNIT IV: Methods To Evaluate The Energy Levels

Tightly bound electron approximation method, application to simple cubic lattice, Wigner-Seitz approximation, pseudo potential method, Fermi surface, experimental methods in Fermi surface studies: quantization of orbits in magnetic field, de Hass van Alphen effect, Fermi surface of copper, Cyclotron resonance, Quantum Hall effect, direct absorption process, indirect absorption process.

COURSE OUTCOMES

- Recognize common crystal structures and describe their symmetries. Describe diffraction using the reciprocal lattice. Determine the structure of crystalline materials by x-ray diffraction
- Use models to calculate dispersion relations for acoustical and optical phonons.
- Perform band structure calculations for simple systems in the weak potential- and in the Linear Combination of Atomic Orbitals approximations. Describe the formation of band-structure in crystals.
- Describe the experimental methods to understand the Fermi surface in crystals.

REFERENCE BOOKS:

1. Introduction to Solid State Physics : Charles Kittel
2. Solid State Physics : A J Dekker

3 Solid State Physics: S.O. Pillai

M.Sc. PHYSICS II SEM

PHL 204

SUBJECT NAME: ELECTRODYNAMICS AND PLASMA PHYSICS

NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVES

To have a deep understanding of electrodynamics using scientific methods and to apply the concepts of electromagnetic theory for various communication systems.

Unit I: Introduction to Electrodynamics (12 hrs.)

Energy stored in an electric and magnetic fields. Continuity Equation, Displacement Current, Maxwell's equations, power flow in an electromagnetic field and pointing theorem. Electromagnetic waves in a homogeneous medium-solution for free space conditions. Uniform plane waves, the wave equations for a conducting medium, Sinusoidal time variations, Maxwell's equations using phasor notation. Wave propagation in a loss less medium, wave propagation in a conducting medium, wave propagation in a good dielectric.

Unit II:Electromagnetic Waves (12hrs)

Reflection & Refraction of Plane waves:- Boundary Conditions, Laws of reflection and refraction of plane waves, Reflection by a perfect dielectric – normal and oblique incidence, Fresnel relations, Brewster's angle, Reflection by a perfect conductor – normal incidence, Power loss in a plane conductor.

Polarization:- Linear, elliptical and circular Polarization, Direction cosines.

Dispersion and Scattering:- Radiative reaction force, scattering and absorption of radiation, Thompson scattering and Rayleigh Scattering, Polarization of Scattered Light, Normal and anomalous dispersion, Dispersion relation of EM waves in Solids, Liquids and gases.

Unit III: Electromagnetic fields and Radiation by Moving Charges (12 hrs.)

Electromagnetic scalar and vector potentials, Maxwell's equations in terms of scalar and vector potentials, Non uniqueness of Electromagnetic potentials and concept of Gauge. Lorentz gauge and coulomb gauge.

Moving point charges, Retarded potentials, Lienard-Wiechart potentials for a point charge, the fields of moving charge particles, Total power radiated by a point charge: Larmor's formula and its relativistic generalization.

Unit IV: Plasma Physics & Waveguides(12 hrs.)

Elementary Concepts: Plasma as fourth state of matter, Various kinds of Plasma, Quasineutrality of plasma, Debye Shielding, Plasma Parameters, Plasma production and heating of the plasma, Plasma Oscillations and plasma frequency expression, Fluid equations, electron plasma wave, ion acoustic wave, Magnetoplasma and Plasma Confinement, plasma instabilities, applications of Plasma.

Wave guides:- TE, TM and TEM waves, TE and TM modes in rectangular wave guides, concept of cut off frequency.

COURSE OUTCOMES

Students who have completed this course should

- Have a deep understanding of electromagnetic theory and propagation of EM waves though various media.
- Be able to understand the phenomena of reflection, refraction, polarization and dispersion of EM waves.
- Understand the fields and potentials due to moving charges.
- Be able to understand the concepts of Plasma Physics and waveguides.

REFERENCE BOOKS:

1.Classical Electrodynamics by J.D. Jackson.
2. Introduction to Electrodynamics by D. J. Griffiths.
3. Introduction to Plasma Physics by Francis F. Chen.
4. Introduction to Electrodynamics by A. Z. Capri and P. V. Panat.

M.Sc. PHYSICS II SEM

PHP 205

SUBJECT NAME: **PHYSICS LAB II**

		SESSIONAL:	30
L	P	THEORY EXAM:	70
0	16	TOTAL:	100

Students assigned the general laboratory work will perform at least 8 experiments of the following:

COURSE OBJECTIVE

To develop basic experimental knowledge in physics by extending knowledge and processes used by physics which produce new and exciting technologies in everyday use.

1. To determine the Ionization potential of Lithium.
2. Determination of range of Beta-rays from Ra and Cs using GM Counter.
3. Measurement of resistivity of a semiconductor by four-probe method at different temperature and determination of band gap.
4. Determination of Lande’s factor of DPPH using ESR spectrometer.
5. Determination of Hall coefficient of a given semiconductor and estimation of charge carrier concentration.
6. Study of Faraday effect using He-Ne Laser. To determine the angle of rotation as a function of the mean flux density using different colour filters. To calculate the corresponding Verdet′s constant in each case and to evaluate Verdet′s constant as a function of the wavelength.
7. Determination of dislocation energy of Iodine molecule by photography the absorption bands of I_2 in the visible region.
8. Determination of the wavelengths of the most intense spectral lines of He and Hg (two electron System).
9. Determination of e/m of electron by normal Zeeman Effect using Febry Perot Etalon.
10. To verify the Compton scattering formula, derived from the quantum theory of electromagnetic radiation, and as a consequence, the mass of the electron will be determined.
11. To understand how electric and magnetic fields impact an electron beam and experimentally determine the electron charge-to-mass ratio.
12. To determine the hysteresis loss by C.R.O, use a hysteresis curve to measure the power loss of an iron core transformer • for comparison, measure the loss for a ferrite core transformer • estimate the Curie point for ferrite.

Note: Addition and deletion in the list of experiments may be made from time to time by the department.

COURSE OUTCOME

On successful completion of this course, students should be able to

- Utilize scientific method for formal investigation of physical laws.
- Demonstrate competency with experimental methods that are used to discover and verify the concepts related to content and research knowledge.

M.Sc. PHYSICS III SEM
PHL 301

SUBJECT NAME: ADVANCED QUANTUM MECHANICS

NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

The aim of the course is to introduce students to the basics of relativistic quantum mechanics, classical and quantum field theories. The course is planned as a continuation of Quantum Mechanics course taught in first semester.

Unit I: Solution of Schrodinger Equation for Three Dimensional Problems: (12hrs)

The Three Dimensional Harmonic Oscillator in both Cartesian and Spherical Polar Coordinates, Eigenvalues Eigenfunctions and the Degeneracy of the States; Solution of the Hydrogen Atom Problem, The Eigenvalues Eigen functions and the Degeneracy.

Unit II: Relativistic Quantum Mechanics (12hrs)

Klein Gordon Equation, Klein Gordon equation in Electromagnetic field, Dirac's relativistic equation, Electromagnetic potentials: Magnetic moment of the electron, Negative energy solution, Anti-particles.

Unit III: Identical Particles (12hrs)

Introduction, Symmetrical and Antisymmetric wave function, Symmetrization postulate, Particle Exchange operator, Distinguishability of Identical particles, The Pauli's Exclusion principle, Slater determinant, Central Field Approximation, Hartee's Self consistent field approximation.

Unit IV: Field Quantization(12hrs)

The Classical approach to Field theory, Relativistic Lagrangian and Hamiltonian of a charged particle in an electromagnetic field, The Lagrangian and Hamiltonian formulation, Creation, Annihilation and Number operators, Field and its canonical quantization, Quantization of Dirac Field. Hydrogen atom.

COURSE OUTCOME

After the successful completion of the course, students would be able to:

- Understand the foundations of Quantum mechanics
- Acquire working knowledge of relativistic quantum mechanics.

- Understand the concept of identical particles
- Understand Field quantization and concepts

REFERENCE BOOKS:

1. Khanna: Quantum Mechanics
2. Lahiri and Pal: A first book on Quantum Mechanics
3. Griener: Quantum Mechanics
4. Liboff: Introductory Quantum Mechanics

M.Sc. PHYSICS III SEM

PHL 302

SUBJECT NAME: STATISTICAL MECHANICS
NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

This course is intended to provide a firm foundation to students in a very fundamental subject of Statistical Mechanics. It aims to derive the macroscopic behavior of a system in terms of mechanics of its microscopic constituents, and finds application in almost all branches of Physics. To demonstrate practical importance of the course, some simple applications from different branches of Physics are included.

Unit I: Ensembles: Review (12hrs)

Micro-canonical Ensemble, Entropy in Statistical Mechanics, Connection between Statistical and Thermo dynamical quantities, perfect gas in micro-canonical Ensemble Partition function, Partition function and Thermo dynamical quantities, Gibb's Paradox, Canonical Ensemble , Perfect Monotonic Gas in Canonical Ensemble, Grand Canonical Ensemble, Perfect Gas in GCE

Unit II: Quantum Statistical Mechanics (12hrs)

Basic concepts, Postulates of Quantum Mechanics, Symmetric and Anti Symmetric Wave functions, Statistical Weight or a Priori Probability, Density Matrix, Bose Einstein Statistics, Fermi Dirac Statistics, Maxwell Boltzmann Statistics, Evaluation of constants α and β, Bose Einstein Gas and Bose Einstein (BE) Condensation, Maxwell Boltzmann distribution as a limiting case of BE distribution, Degeneracy and BE condensation, Correlation to Fermi Dirac gas.

Unit III: Statistical Mechanics of Interacting System (12hrs)

Theory of Imperfect Gases, Cluster Expansion of a Classical Gas, Mayer Cluster Expansion, Determination of Virial Coefficients, Equation of state, Linear Harmonic and Anharmonic oscillators..

Unit IV: Low Temperature Physics (12hrs)

Production and Measurement of Low temperature, Helium I and Helium II, Some Peculiar properties of Helium II and their Explanation, Landau theory, London's Theory, Ising Model .

COURSE OUTCOME

Students who have completed this course should:

- Have a deep understanding of Ensemble theory.
- Be able to solve Quantum statistical mechanics problems for simple non –interacting system,
- Have a basic understanding of Statistical mechanics of interacting system
- Be able to understand low temperature physics.

REFERENCE BOOKS:

1. Patharia: Statistical Mechanics
2. Huang: Statistical Mechanics
3. Ma: Statistical Mechanics
4. Landau and Lifshitz: Statistical Mechanics

M.Sc. PHYSICS III SEM

PHY-303

SUBJECT NAME: LASER TECHNOLOGY

NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

To understand the basic laser fundamentals, unique properties of the laser, types of practical lasers and laser safety and industrial applications of high and low power lasers. Apart from this, topics of current research interest will be also discussed, such as laser cooling and trapping which plays an important role in the realization of Bose-Einstein condensate in atomic vapors.

Unit-I: Basic Principle and Different Lasers (12hrs)

Laser characteristics : Spontaneous and Stimulated Emission, Absorption, Laser Idea, Pumping Schemes, Properties of Laser Beams : Monochromaticity, Coherence, Directionality, Brightness, radiative transition and Amplified Spontaneous Emission, Non-radiative delay, Resonator, rate equations, Methods of Q-switching

Unit-II: Types of Lasers (12hrs)

Principle and Working of CO_2 Laser , Semiconductor Laser. Homo-structure and Hetero-structure P–N Junction Lasers, Nd-YAG Lasers. Principle of Excimer Laser. Principle and Working of Dye Laser. Free Electron Laser. Photo detector p-n diode, nano laser, Ultrafast laser

Unit-III: Non-Linear Processes (12hrs)

Propagation of Electromagnetic Waves in Nonlinear Medium, Self-Focusing, Phase Matching Condition, Raman Scattering: Stimulated Raman Scattering, Hyper Raman Scattering and CARS, Two Photon Absorptions process.

Unit IV: Novel Applications of Laser (12hrs)

Cooling and Trapping of Atoms, Principles of Doppler and Polarization Gradient Cooling, Qualitative Description of Ion Traps, Optical Traps and Magneto-Optical Traps and Bose Condensation.

COURSE OUTCOME

On successful completion of this course, students should be able to:

- Understand the basic principles of laser system
- Know about the working of various laser including gas, liquid and solid state laser
- Understand the non linear processes in which self focusing, phase matching conditions and raman scattering.
- Know cooling and trapping of atoms along with Bose Condensation.

REFERENCE BOOKS:

1. Demtroder: Laser Spectroscopy and Instrumentation
2. Svelto: Principles of Lasers
3. Ghosh: Laser Cooling and Trapping
4. Sengupta: Frontiers in Atomic, Molecular and Optical Physics.

5. Laud: Laser and nonlinear optics

M.Sc. PHYSICS IV SEM

PHY 304
SUBJECT NAME: MICROPROCESSOR

NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

The objective of this course is to familiarize the students with the architecture and the instruction set of an Intel microprocessor 8086. Assembly language programming will be studied as well as the design of various types of digital and analog interfaces. The student will be able to draw a block diagram of a simple computer consisting of a processor, RAM and ROM memory, ports, and the buses that interconnect these components

UNIT I : Introduction to Microprocessor and 8085 Microprocessor (12hrs)

Microprocessor evolution and types, Architecture, Microprocessor and computer languages: machine language, assembly language and high level language, advantage of assembly language, introduction to 8085 microprocessor, internal architecture, Timing and control unit, registers, data and address bus, status flags, pin configuration, Applications of microprocessors.

UNIT II: 8086 Microprocessor (12hrs)

Introduction to 8086, overview of 8086 microprocessor family, 8086 internal Architecture, stack segment register, stack pointer registers, Accessing data in memory, Introduction to programming for 8086 microprocessor, program development steps, constructing the machine code for 8086 instructions, assembly language program development tools, writing simple program for use with an assembler.

UNIT III: 8086Microprocessor System Hardware (12hrs)

Basic 8086 microcomputer system, pin diagram of 8086, minimum and maximum modes, timing diagram, physical memory organization, addressing memory (RAM, ROM) and ports in microcomputer system, 8086 addressing and addressing decoding, programmable parallel ports and handshake input and output, 8255 A internal block diagram, 8255 A operational modes and initialization, pin diagram of 8255 A

UNIT IV: Digital interfacing (12hrs)

Interfacing to keyboards, alphanumeric displays, interfacing microcomputer ports to high power devices Direct Memory Access (DMA) Data Transfer, Timing diagram of 8237 DMA, brief introduction of microcontroller, difference between microprocessor and microcontroller, pin diagram of 8051 microcontroller.

COURSE OUTCOME

- Understanding the basics of microprocessor and 8085 microprocessor.
- Understanding of the Intel 8086 architecture. Knowledge of the 8086 instruction set and ability to utilize it in programming.
- Learning addressing modes (Immediate, direct, extended, indexed modes). Understanding of the Intel 8086 real mode memory addressing.
- Ability to interface various devices to the microprocessor. Introduction to the microcontroller.

REFERENCE BOOKS:

1. Liu and Gibson: Microprocessor System the 8086 / 8088 Family
2. Hall: Microprocessor and Interfacing
3. Ram: Fundamentals of Microprocessor

MSc III SEMESTER LAB

ELECTRONICS LAB II

PHP 305

		SESSIONAL:	25
L	P	THEORY EXAM:	75
0	16	TOTAL:	100

Students assigned the general laboratory work will perform at least 8 experiments of the following:

COURSE OBJECTIVE

- To provide practical knowledge and develop skill in digital system & microprocessor,
- To provide the practical knowledge of microwave test bench &measurement,
- To provide the knowledge of modulation and demodulation.

SYLLABUS

1. Microwave Characteristics and Measurements.
2. Nonlinear Applications of Op Amp.
3. PLL Characteristics and its Applications.
4. PAM, PWM and PPM Modulation and Demodulation
5. PCM / Delta Modulation and Demodulation.
6. Fibre Optic Communication.
7. Arithmetic Operations Using Microprocessors 8085 / 8086.
8. D/A Converter Interfacing and Frequency / Temperature Measurement with Microprocessor 8085 / 8086.
9. A/D Converter Interfacing and AC/DC Voltage / Current Measurement Using Microprocessor 8085/8086.
10. PPI 8251 Interfacing with Microprocessor for Serial Communication.
11. Assembly Language Program on PC

Note: Addition and deletion in the list of experiments may be made from time to time by the department.

COURSE OUTCOME

- The students will understand the operation and design of digital system.
- The students will able to work on microprocessor, interfacing & programming on pc.

M.Sc. PHYSICS IV SEM

PHL 401A

SUBJECT NAME: PHOTONICS

NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

The course aims to provide students with an understanding of basic optics, optical fibre communication system and devices, optical fibre sensors and fibre fabrication.

Unit I : Optical Fiber Waveguides (12hrs)

Introduction; Principle of Light Transmission in a fiber, Ray theory transmission, Electromagnetic mode theory for optical propagation, Modes in a planar waveguide, Fiber index profiles, multi-mode step-index fibers, multi-mode graded index fibers, single mode step index fibers.

Unit II: Input / Output Devices (12hrs)

Optical sources, the Laser, Basic concepts, semiconductor laser, light emitting diode, the semiconductor junction diode; Optical detectors, principle, important parameters of ODs, photodiodes, photo conductors, PIN photodiode

Unit III: Transmission characteristics of Optical Fibers (12hrs)

Attenuation in optical fibers, absorption losses, fiber bend losses, linear scattering losses, Rayleigh scattering, non-scattering losses, Stimulated Brillouin Scattering (SBS), Stimulated Raman Scattering (SRS), Material dispersion, inter-modal dispersion.

Unit IV : Fiber technology Characterization and Optical Communication (12hrs)

Fiber materials, glass fibers, active glass fibers, plastic optical fibers (POF), Photonic crystal fibers (PCF), Index guiding PCF, Photonic band gap fibers, Fiber fabrication, Outside Vapor-phase oxidation, Vapor-phase Axial deposition. Principle components of an O.F.C.S, optical sources, optical detectors, optical amplifier, fiber couplers or directional couplers, Elementary idea of Optical Fiber Sensors

COURSE OUTCOME

After the successful completion of the course, students would be able to

- Understand optical fiber wavegudes and their applications.
- Comprehend the use of input/output devices in optical fiber communication.
- Understand the transmission charscteristics of optical fibers.
- Develop a clear understanding of optical fibre communication, fiber technology and Sensor devices.

REFERENCE BOOKS:

1. Ghatak and Thyagrajan: Introduction to Fiber Optics
2. Keiser: Optical Fiber Communication
3. Gowar: Optical Communication System
4. Sapna Katiyar: Optical Fiber Communication
5. Senior: Optical Fiber Communication

M.Sc. PHYSICS IV SEM

SUBJECT NAME: RADIATION PHYSICS (PHL 401B)

NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

The course aims to provide students with a deep understanding of radiation physics. The course also aims to make students familiar with thermal neutrons, nuclear spectrometry and analytical techniques.

Unit I: Thermal Neutrons (12hrs)

Energy distribution of thermal neutrons, Effective cross-section of thermal neutrons, lowing down of reactor neutrons, Angular and energy distribution, Transport mean free path and scattering cross-section, Average logarithmic energy decrement, slowing down power and moderating ratio, Slowing down density, slowing down time, Resonance escape probability

UnitII: Nuclear Chain Reaction and Nuclear diffusion (12hrs)

Neutron cycle and multiplication factor, Neutron leakage and critical size, Nuclear reactor and their classification. Thermal neutron diffusion, Neutron diffusion equation, Thermal diffusion length, Exponential pile, Diffusion length of a fuel moderator mixture, Fast neutron diffusion and Fermi age equation, Correction of neutron capture**.**

Unit III: Nuclear Spectrometry and Applications (12hrs)

Analysis of nuclear spectrometric data, Measurements of nuclear energy levels, spins parities, moments, internal conversion coefficients, Angular correlation, Perturbed angular correlation, Measurement of g factors and hyperfine fields.

Unit IV: Analytical Techniques (12hrs)

Principles, Instrumentation and spectrum analysis of XRF, PIXE and neutron activation analysis techniques. Theory, instrumentation and applications of electron spin resonance (ESR) spectroscopy. Experimental techniques and applications of Mossbauer Effect, Rutherford backscattering.

COURSE OUTCOME:

After the successful completion of the course, the students would be able to :

- Understand the properties of thermal neutrons.
- Understand nuclear chain reactions and nuclear diffusion.
- Understand nuclear spectro-photometry and applications
- Use analytical techniques such as XRF, PIXE etc.

REFERENCE BOOKS:

1. Singru RM: Introduction to experimental nuclear physics
2. Glasstone and Edlund: The elements of nuclear reactor theory.
3. Murray: Introduction to nuclear engineering
4. Krane K.S: Introductory Nuclear Physics

M.Sc. PHYSICS IV SEM

PHL 402A

SUBJECT NAME: ELECTRONIC COMMUNICATION SYSTEM

NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

The course aims to develop an understanding of microwaves, waveguide and klystron. The course aims to develop knowledge of Radar functions and its application. It also aims develop an understanding of communication system and signals.

Unit I: Introduction to communication system (12hrs)
Information transmitter, channel noise, receiver, need for modulation bandwidth requirements, noise and its types, representation of AM, frequency spectrum, power relations in AM wave, techniques for generation of AM, AM transmitter, AM receiver types, single and multi-super hetrodyne receivers, communication receivers

Unit II: Frequency modulation and radar system (12hrs)
Description of FM systems, mathematical representation, comparison of wide band and narrow band FM, FM generation techniques, FM demodulators, FM receivers

Radar systems: Basics principals, pulsed radar systems, moving targets indication, radar beacons, CW Doppler radar, frequency modulated CW radar, phased array radars, planar array, radar

Unit III: Pulse communication (12hrs)
Information theory, pulse modulation, types of pulse modulation, pulse amplitude modulation (PAM), pulse width modulation (PWM), pulse position modulation (PPM) and pulse code modulation (PCM), PCM transmission system, telegraphy.

Unit IV: Broadband communication system (12hrs)
Frequency division multiplex (FDM), Time division multiplex (TDM), coaxial cables, fiber optics links, microwave links, tropospheric scatter links, submarine cables, satellite communication systems, elements of long distance telephony

COURSE OUTCOME

Students who have completed this course should:

- Gain knowledge and understanding of communication systems.
- Have basic knowledge of frequency modulation and radar system.

- Have knowledge of pulse communication and its applications
- Comprehend broadband communications.

REFERENCE BOOKS:

1. Haykin: Communication System
2. Kennedy: Electronics and communication system
3. Kulkarni: Microwave and radar engineering
4. Roddy and Coolen: Electronics Communication

M.Sc. PHYSICS IV SEM

PHL 402B
SUBJECT NAME: ELECTRONIC DEVICES AND COMMUNICATION

NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE:

The aim of the course is to provide students with a thorough knowledge of Semiconductor devices, Microwave devices and memory devices.

Unit I: Semiconductor Devices (12hrs)

Review of p-n junction, metal semiconductor and metal oxide semiconductor junctions, review of JFET, MESFET and MOSFET- their frequency limits. Noise: Signal to noise ratio (SNR) and enhancement of SNR in instrumentation and communication

Unit II: Microwave Devices (12hrs)

Tunnel diode, transfer electron devices (Gunn diode), Avalanche transit time devices (Reed, Impact diodes, parametric devices), vacuum tube devices, reflex klystron and magnetron.

Unit III: Memory Devices(12hrs)

Volatile static and D-RAM, CMOS and NMOS, non volatile-NMOS, ferroelectric semiconductors, optical memories, magnetic memories, charge coupled devices (CCD), Piezoelectric, pyroelectric and magnetic devices, SAW and integrated devices.

Unit IV: Communication (12hrs)

Basics of Modulation and demodulations, Difference between AM, FM and PM, mathematical and graphical analysis of AM signals, power relation, generation of AM waves, Block diagram of digital communication system, different communication techniques, advantage of digital communication, radar block diagram, basic radar range equation.

COURSE OUTCOME:

After the successful completion of the course, students would be able to:

- Understand the construction and working semiconductor devices, p-n junction, MOSFET etc
- Have an in-depth knowledge of microwave devices.
- Understand the basic principle of memory devices.
- Understand the principle of communication and its various techniques.

REFERENCE BOOKS:

1. Haykin: Communication System
2. Kennedy: Electronics and communication system
3. Kulkarni: Microwave and radar engineering
4. Roddy and Coolen: Electronics Communication

M.Sc. PHYSICS IV SEM

CODE: PHL -403A
SUBJECT NAME: **NANO SCIENCE AND TECHNOLOGY**

NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

Introduction to the underlying principles and applications of the emerging field of nanotechnology and nanoscience along with able to practically synthesize and characterize the nano material. Moreover this course introduces tools and principles which are relevant at the nanoscale dimension. Current and future nanotechnology applications in engineering, materials, physics etc will be discussed.

UNIT-1: Introduction to Nano Science and Nano Technology (12hrs)

Introduction to nanomaterials, Band Structure, Density of states of nanoscale Size, dimensionality effects, size effects, properties of materials & nanomaterials; Era of nanostructres of carbon: Fullerenes, Graphene and Carbon Nano Tubes, BN Nano Tubes.

UNIT-II: Quantum Mechanics for Nanoscience (12hrs)

Quantum Well Structures: electron confinement in infinitely deep square well, confinement in one and two dimensional well, idea of a quantum well structure, quantum dots, quantum wires. Resonant tunneling quantized energy levels, reflection and transmission by a potential step and by a rectangular barrier, Quantum confinement effect in nanomaterials.

UNIT-III: Growth Techniques of Nanomaterials (12hrs)

Top-Down & Bottom-Up, Lithographic techniques and its limitations, Non lithographic techniques, Fabrication of Nanomaterials by different Methods: -Plasma Arc discharge, Sputtering, pulse laser deposition, Ball Milling, Molecular beam epitaxy, Evaporation, Chemical vapour deposition, Electro deposition, Sol gel Method.

UNIT-IV: Characterization Tools of Nanomaterials and Applications (12hrs)

Electron Microscopy: SEM and TEM, Scanning Probe Microscopy (SPM), TEM, Scanning Tunneling Microscopy (STM), Atomic force Microscopy (AFM). UV-visible, Deep Level Transmission(DLT) and Raman spectroscopy.

COURSE OUTCOME

After the successful completion of the course, students would be able:

- To understand the basics of Nano Science and Nano Technology.
- To apply the Quantum Mechanics for Nanomaterials.
- To learn the various Growth Techniques of Nanomaterials.
- To use the Characterization Tools of Nanomaterials for research applications.

REFERENCE BOOKS:

1. Poole and Owens: Introduction to Nanotechnology
2. Nanoscale materials -Liz Marzan and Kamat
3. Nanoscience & Technology: Novel structure and phenomea by Ping Sheng (Editor)
4. Nano Engineering in Science & Technology: An introduction to the world of nano design by Michael Rieth.
5. Nanotubes and Nanowires- CNR Rao and A Govindaraj RCS Publishing
6. Nalva (editor): Handbook of Nanostructured Materials and Nanotechnology

M.Sc. PHYSICS IV SEM

PHL - 403 B

SUBJECT NAME: COMPUTATIONAL PHYSICS

NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE:

This course aims to develop in students computations skills to handle problems in theoretical and experimental physics. The student would be able to handle problems in differentiation and integration, solution of differential equations and simulate specific physical problems.

Unit I: Differentiation and Integration (12 hrs.)

Differentiation: Taylor series method, Numerical differentiation using Newton's forward difference formula, Backward difference formula, Stirling's formula, Cubic splines method; Integration: Trapezoidal rule, Simpson's 1/3 rule, Gaussian Quadrature, Legendre–Gauss Quadrature, Numerical double integration, Numerical integration of singular integrals.

Unit II: Solution of Differential Equations (12 hrs.)

Numerical solution of ordinary differential equations: Taylor's series method, Euler's method, Forth-order Runge Kutta method, Cubic splines method; Second order differential equations:

Initial and boundary value problems, Numeric solution of Radial Schrodinger equation for Hydrogen atom using Forth-order Runge-Kutta method(when eigenvalue is given), Numerical Solutions of Partial Differential Equations Using Finite Difference Method.

Unit III: Random Numbers and Chaos (12 hrs.)

Random numbers: Random number generators, Mid-square methods, Multiplicative congruential method, mixed multiplicative congruential methods, modeling radioactive decay. Hit and miss Monte-Carlo methods, Monte-Carlo calculation of π, Monte-Carlo evaluation of integration, Evaluation of multidimensional integrals; Chaotic dynamics: Some definitions, The simple pendulum, Potential energy of a dynamical system. Portraits in phase space: Undamped motion, Damped motion, Driven and damped oscillator.

Unit IV: Simulation of selected physics problems (12 hrs.)

Algorithms to simulate interference and diffraction of light, Simulation of charging and discharging of a capacitor, current in LR and LCR circuits, Computer models of LR and LCR circuits driven by sine and square functions, Computer model of Rutherford scattering experiment, Simulation of electron orbit in H_2 ion.

COURSE OUTCOME:

After the successful completion of the course, the student would be able to:

- Learn about the various integration and diffractions methods.
- Deduce Numerical solution of ordinary differential equations.
- Generate the random numbers using various techniques.
- Simulate selected physics problems using various computational methods.

REFERENCE BOOKS:

1. F B Hildebrand: Introduction to Numerical Analysis, Tata McGraw Hill, New Delhi.
2. R C Desai: Fortran Programming and Numerical methods, Tata McGraw Hill, New Delhi.
3. Suresh Chandra: Computer Applications in Physics, Narosa Publishing House.
4. William H. Press, Saul A Teukolsky, William T Vellerling and Brain P. Flannery: Numerical Recipes in Fortran, Cambridge University Press.
5. M L De Jong: Introduction to Computation Physics, Addison-Wesley publishing company.

M.Sc. PHYSICS IV SEM

PHL 404A

SUBJECT NAME: MATERIAL SCIENCE

NO OF CREDITS: 4

			SESSIONAL:	25
L	P		THEORY EXAM:	75
4	0		TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

Expose the students to different classes of materials, Metals, Ceramics, Polymers, Composites, their properties, structures, imperfections, Defects and Diffusion present in them. Manipulate atomic/micro structural processes to create desired structure & processes.

Unit I: Imperfections in Solids (12 hrs.)

Point Defects: vacancy, substitutional, interstitial, Frenkel and Schottky defects, equilibrium concentration of Frenkel and Schottky defects**;** Line Defects: slip planes and slip directions, edge and screw dislocations, Burger's vector, cross-slip, glide and climb, jogs, dislocation energy, super & partial dislocations, dislocation multiplication, Frank Read sources; Planar Defects: Free energy, grain boundaries, twin interfaces, and stacking fault; volume Defects: precipitates and dispersants

Unit II: Mechanical Properties (12 hrs.)

Stress Strain Curve; Stress: tensor and concentration; stress in two dimension, Elastic Deformation: Isotropic and Anisotropic; Anelastic and Viscous deformation; Plastic Deformation: True stress and Strain, Critically resolved shear stress; Slip theory: Perfect and real crystal; Strengthening Mechanisms: work hardening, recovery, recrystallization, strengthening from grain boundaries, strain aging, solid solution strengthening; Creep & its Mechanism, Fracture: Introduction.

Unit III: Metallurgy (12 hrs.)

Solid Solutions and Intermediate Phases: phase rule, unitary & binary phase diagrams, Lever rule, Hume-Rothery rule; Free Energy and Equilibrium Phase Diagrams: complete solid miscibility, partial solid miscibility-eutectic, peritectic and eutectoid reactions, eutectaid mixture; Diffusion: Fick's law, Kirkendall Effects, Atomic model of diffusion, Nernst-Einstein relation Phase transformation: Nucleation, Growth and Overall Transformation Kinetics, and Process: Precipitation, Solidification, Crystallization, and Glass transition

UNIT IV: Materials Characterization (12 hrs.)

Ion Implantation: introduction, ion implantation process, depth profile, radiation damage and energy losses: Nuclear and electronic; Ion Beam characterization Technique: Rutherford Backscattering Spectrometry (RBS): principle, kinematics of elastic collision, shape of the backscattering spectrum, depth profiles and concentration analysis, Elastic Recoil Detection Analysis (ERDA): basic principle, kinematics, concentration analysis, depth profiling, depth resolution, Secondary Ion Mass Spectroscopy (SIMS): basic principle, working, yield of secondary ions and applications.

COURSE OUTCOME

After the successful completion of the course, the student would be able to:

- Understand structure and defects based properties relationship for Crystal Metals & Ceramics materials
- Gain knowledge of behavior of metal, ceramic and polymers under mechanical forces
- Select materials for design and construction
- Understand Material characterization through Ion beam techniques

REFERENCE BOOKS:

1. Material Science by J. C. Anderson, K. D. Leaver, J. M. Alexander and R. D. Rawlings
2. Mechanical Metallurgy by G. E. Dieter
3. Materials Science and Engineering by V. Raghavan
4. Fundamentals of Surface and Thin Film Analysis by L.C. Feldman and J.W. Mayer

M.Sc. PHYSICS IV SEM

PHL 404B

SUBJECT NAME: SMART MATERIALS

NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

The goal of this course is to expose the students to the general area of smart materials like composites, polymers, dielectrics and ceramics with an emphasis on novel materials and emerging applications. Students will learn the potentials of smart sensors and actuators, the challenges associated with their uses.

Unit I: Composite materials (12hrs)
Agglomerated composites, cermets, laminates, Reinforced composite materials, classification of reinforced composite materials, flakes composite, whisker reinforced composites, hybrid composites, sandwich composites, fiber reinforced glass and glass ceramic composites, polymer concrete, fiber reinforced concrete (pRC), MMC and wood composites, advantages and limitations of composites, fibers, forms of reinforcing fibers, mechanic of composite laminates, generalized Hook's law and elastic constants

Unit II: Ceramic materials (12hrs)
Refractories, silica and silicates, glasses, glass-forming constituents, types of glasses, perovskite structure of mixed oxides, lime, cement, cement concrete, reinforced cement concrete (RCC), pre-stressed concrete, rocks and stones, clay and clay based ceramics, chemically bonded ceramics.

Unit III: Materials and Alloys (12hrs)
Alloys, Alloys in different applications, heat resisting alloys, Cryogenic alloys, bearing metals (Baaits), Metals and alloys for nuclear industry, common ferrous and non ferrous alloys, monomers of polymer, Degree of polymerization, Mechanism of polymersation, additives in polymers, strengthening mechanism of polymers, deformation of polymers.

Unit IV Dielectric materials
Classification of dielectrics, polarization, basic properties of dielectrics, electrical susceptibility, power loss, electric breakdown, effect of temperature and frequency on permittivity, insulating materials, ferro-electrics, piezo-electrics, electrets, pyroelectrics and elecrostriction

COURSE OUTCOME

After the successful completion of the course, the student would be able to:

- Understand the structure of composite materials and the areas of application.
- Differentiate between different types of ceramics, their synthesis and different constituents
- Learn about the various kind of materials and their alloys for different industrial applications.
- Classify the various kinds of dielectrics and their applications in different devices.

REFERENCE BOOKS:

1. Material Science by J. C. Anderson, K. D. Leaver, J. M. Alexander and R. D. Rawlings

2. Mechanical Metallurgy by G. E. Dieter
3. Material Science and Engineering: K M Gupta

AUDIT COURSE
COURSE CODE: APHL-203A

SUBJECT NAME: RENEWABLE ENERGY RESOURSES

		SESSIONAL:	25
L	P	THEORY EXAM:	75
3	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE: This course will enable students learn and understand the importance of alternate energy resources. They will also study the fundamentals of renewable energy resources.

SYLLABUS

UNIT I: PRINCIPLES OF SOLAR RADIATION:

Limitation of conventional energy sources, need and growth of alternative energy sources, basic scheme and application of direct energy conservation, Role and potential of new and renewable source, the solar energy option, Environmental impact of solar power, physics of the sun, the solar constant, extraterrestrial and terrestrial solar radiation, solar radiation on titled surface, instruments for measuring solar radiation and sun shine, solar radiation data.

UNIT II: SOLAR ENERGY COLLECTION, STORAGE AND APPLICATIONS

Flat plate and concentrating collectors, classification of concentrating collectors, orientation and thermal analysis, advanced collectors; Different methods of storage: Sensible, latent heat and stratified storage, solar ponds. Solar Applications- solar heating/cooling technique, solar distillation and drying, photovoltaic energy conversion.

UNIT III: WIND ENERGY AND GEOTHERMAL ENERGY

Wind energy: Sources and potentials, horizontal and vertical axis windmills, performance characteristics, Betz criteria; Geothermel energy: Resources, types of wells, methods of harnessing the energy, potential in India.

UNIT IV: OCEAN ENERGY

OTEC, Principles utilization, setting of OTEC plants, thermodynamic cycles. Tidal and wave energy: Potential and conversion techniques, mini-hydel power plants, and their economics.

COURSE OUTCOME:

At the end of the course, a fully engaged student will be able to:

1. Understand the principles of solar energy and its environmental impact.
2. Learn the basics of solar energy collection and storage.
3. Study the basics of wind energy and geothermal energy.
4. Comprehend the use of ocean energy as an alternate source of energy.

REFERENCE BOOKS:

1. Renewable energy resources/ Tiwari and Ghosal/ Narosa.
2. Renewable Energy Technologies /Ramesh & Kumar /Narosa
3. Non-Conventional Energy Systems / K Mittal /Wheeler
4. Renewable energy sources and emerging technologies by D.P.Kothari,K.C.Singhal, P.H.I.

5. Non-Conventional Energy Sources /G.D. Rai, Khanna Publishers
6. Renewable Energy Resources – Twidell & Wier, CRC Press(Taylor & Francis)

OPEN ELECTIVE

COURSE CODE: OPHL-305A

INTRODUCTION TO ASTROPHYSICS AND COSMOLOGY

NO. OF CREDITS-3

		SESSIONAL:	25
L	P	THEORY EXAM:	75
3	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE:

To show how the properties of astronomical objects and the Universe relate to simple physical laws and processes

SYLLABUS

UNIT I :The Universe and its physics: A tour of the Universe, its scale and contents; Gravity; Pressure; Radiation Observational astronomy**:** the electromagnetic spectrum; geometrical optics; resolving power, and the diffraction limit; telescopes and detectors; gravitational waves; Distances**:** parallax measurements, standard candles

UNIT II: Physics of the Sun and Stars: blackbody radiation, the Planck, Stefan-Boltzmann and Wien laws, effective temperature, interstellar reddening; hydrogen spectral lines and Doppler effect; Hertzprung-Russell diagram; Freefall and Kelvin-Helmholtz time; nuclear fusion; basic stellar structure (hydrostatic equilibrium, equation of state); white dwarfs, neutron stars and black holes

UNIT III: Planetary systems: Kepler's laws; Detection methods of extrasolar planets; search for life elsewhere.

UNIT IV: Star formation: the interstellar medium; stellar populations; the interstellar medium; galaxy rotation curves, mass and dark matter; Galaxy collisions; central engines; Cosmology**:**Olber's paradox, Hubble's Law; the age of the Universe; Evolution of the Universe: Madau diagram; Evidence for the Big Bang (blackbody radiation, nucleosynthesis); dark energy and the accelerating Universe.

COURSE OUTCOMES

On completion successful students will be able to:

1. Have an understanding of the role and physics of detectors and telescopes including geometric optics and understand how distances are measured.
2. Know how basic laws of physics determine the properties and evolution of stars.
3. Know Kepler's Laws and how they relate to extrasolar planet detection.
4. Understand how the dynamics of galaxies indicate the presence of dark matter and demonstrate an understanding of the evolution of our Universe.

References:

1. Carroll, B.W. & Ostlie, D.A., *An Introduction to Modern Astrophysics* (Pearson)

OPEN ELECTIVE
COURSE CODE: OPHL-306A

PHYSICS AND OUR WORLD

SESSIONAL: 25

L	P		THEORY EXAM:	75
3	0		TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

The course aims to provide the students fundamentals of Physics and of our world

UNIT-I: Space and Time

A discussion on length scales and dimensions, Galaxies, The solar system and the planet Earth, Rotation and Revolution of the Earth, Seasons, Calendars in History and the recording of time, Laws of motions- A Discussions of principles, theories and models, Gravitation, Planetary motion and Keplar's Laws, the laws of motion in the eyes of Galileo and Newton.

UNIT-II: Theory of Relativity

The relationship between Space and time: A basic account of theory of Relativity, Does nature differentiate between left and right ?- The notion of Parity, Is there an "Arrow" of time?. Entropy and Laws of Thermodynamics, The Size of the Universe- Is the Universe expanding?

UNIT-III: Matter and Energy

Discrete and continuous matter- a brief historical survey, Atoms and molecule: Structure of atoms, the nucleus, Elementary particles, Unification of forces. Equivalence of matter and energy, Nuclear energy and thermodynamics power. The Periodic table of elements, chemical bonds and molecules, Large molecules and living matter.

UNIT-IV Electromagnetic Energy

Waves and oscillations, Electromagnetic radiation and spectrum, Propagation of waves, Energy in the atmosphere- Wind and solar energy, Weather predictability and chaos, Indeterminacy, The quantum world—an introduction, Debates on the conceptualization of physical realities- is nature unreasonably mathematical?

COURSE OUTCOME

On successful completion of this course, students should be able to :

- Understand the relation between space and time.

- Learn the about the elementary particles and equivalence of energy and matter
- Learn about matter and energy
- Comprehend the basics of Electromagnetic energy

REFERENCE BOOKS:

1. The Evolution of Physics-Einstein and L. Infeld, Toughstone 1967
2. The Ascent of Man-J. Bronowski, laffle and Brown Company, 1976
3. Commos- Carl sagan, McDonald and Company, 2003.

FACULTY OF SCIENCES

DEPARTMENT OF PHYSICS

B.Sc. (Hons.) Physics

w.e.f. Session 2017-2018

YMCA UNIVERSITY OF SCIENCE AND TECHNOLOGY

YMCA UNIVERSITY OF SCIENCE AND TECHNOLOGY

VISION

YMCA University of Science and Technology aspires to be a nationally and internationally acclaimed leader in technical and higher education in all spheres which transforms the life of students through integration of teaching, research and character building.

MISSION

- To contribute to the development of science and technology by synthesizing teaching, research and creative activities.
- To provide an enviable research environment and state-of-the art technological exposure to its Scholars.
- To develop human potential to its fullest extent and make them emerge as world class leaders in their professions and enthuse them towards their social responsibilities

HUMANITIES AND SCIENCES DEPARTMENT

VISION

A department that can effectively harness its multidisciplinary strengths to create an academically stimulating atmosphere; evolving into a well-integrated system that synergizes the efforts of its competent faculty towards imparting intellectual confidence that aids comprehension and complements the spirit of inquiry.

MISSION

- To create well-rounded individuals ready to comprehend scientific and technical challenges offered in the area of specialization.
- To counsel the students so that the roadmap becomes clearer to them and they have the zest to turn the blueprint of their careers into a material reality.
- To encourage critical thinking and develop their research acumen by aiding the nascent spirit for scientific exploration.
- Help them take economic, social, legal and political considerations when visualizing the role of technology in improving quality of life.
- To infuse intellectual audacity that makes them take bold initiatives to venture into alternative methods and modes to achieve technological breakthroughs.

B.Sc. (Hons.) Physics

Physics is the most fundamental of the sciences. New concepts, such as Quantum Mechanics and Relativity, are introduced at degree level in order to understand nature at the deepest level.

These theories have profound philosophical implications because they challenge our view of the everyday world. At the same time they have a huge impact on society since they underpin the technological revolution. While studying one of the most intellectually satisfying disciplines, you will acquire transferable skills including numeracy, problem solving, an ability to reason clearly and communicate well. Core physics topics include: Newtonian Dynamics, Wave Phenomena, The Material Universe, Working with Physics, Practical Physics and Maths for Physics, Electromagnetism, Condensed Matter, Quantum and Atomic Physics and Nuclear and Particle Physics.

A wide range of options is available including Medical Physics, Astronomy, Statistical and Low Temperature Physics and Surface Physics. You will also take Mathematics, Computing and Experimental Physics modules in support of these studies. The programme includes a one-semester project in one of the research groups.

PROGRAM OBJECTIVES

- Producing graduates who are well grounded in the fundamentals of Physics and acquisition of the necessary skills, in order to use their knowledge in Physics in a wide range of practical application.
- Developing creative thinking and the power of imagination to enable graduates work in research in academia and industry for broader application.
- Accommodating their relevant fields in allied disciplines and to allow the graduates of Physics to fit into the inter-disciplinary environment.
- Relating the training of Physics graduates to the employment opportunities within the country.

It also promotes research and creative activities of students by providing exposure to the realm of physical science and technical expertise. The B.Sc. (Hons.) programme in physics is designed to provide a thorough basic knowledge in physics at the under graduate level. Apart from the general topics in physics, many of the new topics included in the syllabus keeps the students abreast with the latest developments taking place in the field. Also the experiments chosen for each practical course is such that they bring out the concept of application of the theory in a practical situation. It also helps in creative thinking and self-learning.

PROGRAM OUTCOMES

After completion of the program, the students will:

- have a strong foundation of pure and applied Physics by means of various theoretical and laboratory work.
- Provide a systematic understanding of core physical concepts, principles and theories along with their applications.
- To visualize and analyze various real life problems using Physics.
- To develop analytical & soft skills, reasoning & quantitative aptitude.
- Apart from Physics as a major subject, students will have the basic knowledge of communication & environmental sciences.
- The students will be able to learn computer Science/Mathematics/Chemistry/Electronics as an elective subject.
- To develop a career in the field of Research & Development, Banking, Industry, Defence & Civil Services etc.

YMCA UNIVERSITY OF SCIENCE AND TECHNOLOGY, FARIDABAD
DEPARTMENT OF HUMANITIES AND SCIENCES
STRUCTURE AND SYLLABI OF B.Sc. (Hons.) PHYSICS (6 SEMESTER COURSE)

SEMESTER - I

Subject Code	Title	L	T	P	Internal Assessment	End-semester Examination	Total	Credits	Category Code
Discipline Core Course (DCC) – Compulsory									
BPH 101	Mathematical Physics-I	4	0	0	25	75	100	4	DCC
BPH 102	Mechanics	4	0	0	25	75	100	4	DCC
BPH 103	Mathematical Physics-I Lab	0	0	4	15	35	50	2	DCC
BPH 104	Mechanics Lab	0	0	4	15	35	50	2	DCC
Ability Enhancement Compulsory Course (AECC) – Compulsory									
BENG 101	English	2	0	0	25	75	100	2	AEC
Open Elective Course (OEC-I) - Select 1-paper & respective Lab (if any) of the following 4-disciplines									
OMTH 101	Calculus	5	1	0	25	75	100	6	OEC
OELC 101	Electronic circuit & PCB Designing	4	0	0	25	75	100	4	OEC
OCSC 101	Introduction to Programming	4	0	0	25	75	100	4	OEC
OCHE 101	Inorganic Chemistry	4	0	0	25	75	100	4	OEC
OELC 102	Electronic circuit & PCB Designing Lab	0	0	4	15	35	50	2	OEC
OCSC 102	Introduction to Programming Lab	0	0	4	15	35	50	2	OEC
OCHE 102	Inorganic Chemistry Lab	0	0	4	15	35	50	2	OEC
Massive Open Elective Course (MOOC)*- Online Compulsory Course in any one semester from Sem-I to Sem-V									
XXX	MOOC	4/6	0	0	25	75	100	4/6	MOOC
Total Credits								**20**	

*The students have to pass at least one mandatory MOOC course with 4-6 credits (12-16 weeks) from the list given on the Swayam portal or the list given by the department/ university from 1st semester to 3rd semester as notified by the university. (Instructions to students overleaf)
L – Lecture; T - Tutorial; P - Practical

SEMESTER - II

Subject Code	Title	L	T	P	Internal Assessment	End-semester Examination	Total	Credits	Category Code
Discipline Core Course (DCC) – Compulsory									
BPH 201	Electricity & Magnetism	4	0	0	25	75	100	4	DCC
BPH 202	Waves & Optics	4	0	0	25	75	100	4	DCC
BPH 203	Electricity & Magnetism Lab	0	0	4	15	35	50	2	DCC
BPH 204	Waves & Optics Lab	0	0	4	15	35	50	2	DCC
Ability Enhancement Compulsory Course (AECC) – Compulsory									
BEVS 101	Environmental Science	2	0	0	25	75	100	2	AEC
Open Elective Course (OEC-2) - Select 1- paper & respective Lab(if any) of the following 4-disciplines									
OMTH 201	Linear Algebra	5	1	0	25	75	100	6	OEC
OELC 201	Instrumentation	4	0	0	25	75	100	4	OEC
OCSC 201	Introduction to Database System	4	0	0	25	75	100	4	OEC
OCHE 201	Physical Chemistry	4	0	0	25	75	100	4	OEC
OELC 202	Instrumentation Lab	0	0	4	15	35	50	2	OEC
OCSC 202	Introduction to Database System Lab	0	0	4	15	35	50	2	OEC
OCHE 202	Physical Chemistry Lab	0	0	4	15	35	50	2	OEC
Massive Open Elective Course (MOOC) – Online Compulsory Course in any one semester from Sem-I to Sem-V									
XXX	MOOC	4/6	0	0	25	75	100	4/6	MOOC
Mandatory Audit Course (MAC)									
XXX	Audit Course#	2	0	0	25	75	100	0	AUD
Total Credits								**20**	

As per the list provided by University site

SEMESTER - III

Subject Code	Title	L	T	P	Internal Assessment	End-semester Examination	Total	Credits	Category Code
Discipline Core Course (DCC) – Compulsory									
BPH 301	Mathematical Physics-II	4	0	0	25	75	100	4	DCC
BPH 302	Thermal Physics	4	0	0	25	75	100	4	DCC
BPH 303	Analog Systems & Applications	4	0	0	25	75	100	4	DCC
BPH 304	Mathematical Physics-II Lab	0	0	4	15	35	50	2	DCC
BPH 305	Thermal Physics Lab	0	0	4	15	35	50	2	DCC
BPH 306	Analog Systems & Applications Lab	0	0	4	15	35	50	2	DCC
Skill Enhancement Course (SEC) – Select 1-paper and respective lab out of the following									
SECP 01	Computational Physics Skills	2	0	0	25	75	100	2	SEC
SECP 02	Electrical Circuits & Network Skills	2	0	0	25	75	100	2	SEC
SECP 03	Basic Instrumentation Skills	2	0	0	25	75	100	2	SEC
SECP 04	Computational Physics Skills Lab	0	0	2	15	35	50	0	SEC
SECP 05	Electrical Circuits & Network Skills Lab	0	0	2	15	35	50	0	SEC
SECP 06	Basic Instrumentation Skills Lab	0	0	2	15	35	50	0	SEC
Open Elective Course (OEC-3) – Select 1- paper & respective Lab(if any) of the following 4-disciplines									
OMTH 301	Differential Equations	5	1	0	25	75	100	6	OEC
OELC 301	Communication Systems	4	0	0	25	75	100	4	OEC
OCSC 301	Computer Networks & Internet Technology	4	0	0	25	75	100	4	OEC

OCHE 301	Organic Chemistry	4	0	0	25	75	100	4	OEC
OELC 302	Communication Systems Lab	0	0	4	15	35	50	2	OEC
OCSC 302	Computer Networks & Internet Technology Lab	0	0	4	15	35	50	2	OEC
OCHE 302	Organic Chemistry Lab	0	0	4	15	35	50	2	OEC
Massive Open Elective Course (MOOC) – Online Compulsory Course in any one semester from Sem-I to Sem-V									
XXX	MOOC	4/6	0	0	25	75	100	4/6	MOOC
Total Credits								**26**	

SEMESTER - IV

Subject Code	Title	L	T	P	Internal Assessment	End-semester Examination	Total	Credits	Category Code
Discipline Core Course (DCC) – Compulsory									
BPH 401	Mathematical Physics-III	4	0	0	25	75	100	4	DCC
BPH 402	Elements of Modern Physics	4	0	0	25	75	100	4	DCC
BPH 403	Digital Systems & Applications	4	0	0	25	75	100	4	DCC
BPH 404	Mathematical Physics-III Lab	0	0	4	15	35	50	2	DCC
BPH 405	Elements of Modern Physics Lab	0	0	4	15	35	50	2	DCC
BPH 406	Digital Systems & Applications Lab	0	0	4	15	35	50	2	DCC
Skill Enhancement Course (SEC) – Select 1-paper and respective Lab out of the following (not opted in Sem-III)									
SECP 01	Computational Physics Skills	2	0	0	25	75	100	2	AEEC
SECP 02	Electrical Circuits & Network Skills	2	0	0	25	75	100	2	AEEC
SECP 03	Basic Instrumentation Skills	2	0	0	25	75	100	2	AEEC
SECP 04	Computational Physics Skills Lab	0	0	2	15	35	50	0	SEC
SECP 05	Electrical Circuits & Network Skills Lab	0	0	2	15	35	50	0	SEC
SECP 06	Basic Instrumentation Skills Lab	0	0	2	15	35	50	0	SEC
Open Elective Course (OEC-3) – Select 1- paper & respective Lab (if any) of the following 4-disciplines									
OMTH 401	Numerical Methods	5	1	0	25	75	100	6	OEC
OELC 401	Microprocessor & Microcontroller Systems	4	0	0	25	75	100	4	OEC
OCSC 401	Information Security	4	0	0	25	75	100	4	OEC
OCHE 401	Spectroscopy	4	0	0	25	75	100	4	OEC
OELC 402	Microprocessor &	0	0	4	15	35	50	2	OEC

	Microcontroller Systems Lab								
OCSC 402	Information Security Lab	0	0	4	15	35	50	2	OEC
OCHE 402	Spectroscopy Lab	0	0	4	15	35	50	2	OEC
Massive Open Elective Course (MOOC) – Online Compulsory Course in any one semester from Sem-I to Sem-V									
XXX	MOOC	4/6	0	0	25	75	100	4/6	MOOC
Total Credits								**26**	

SEMESTER - V

Subject Code	Title	L	T	P	Internal Assessment	End-semester Examination	Total	Credits	Category Code
Discipline Core Course (DCC) – Compulsory									
BPH 501	Quantum Mechanics & Applications	4	0	0	25	75	100	4	DCC
BPH 502	Solid State Physics	4	0	0	25	75	100	4	DCC
BPH 503	Quantum Mechanics & Applications Lab	0	0	4	15	35	50	2	DCC
BPH 504	Solid State Physics Lab	0	0	4	15	35	50	2	DCC
Discipline Elective Course (DEC) select any 2-papers & respective labs (if any) out of the following 3-papers									
DECP 501	Atomic & Molecular Physics	5	1	0	25	75	100	6	DEC
DECP 502	Experimental Techniques	4	0	0	25	75	100	4	DEC
DECP 503	Linear Algebra & Tensor Analysis	5	1	0	25	75	100	6	DEC
DECP 504	Experimental Techniques Lab	0	0	4	15	35	50	2	DEC
DECP 505	Biological & Medical Physics	5	1	0	25	75	100	6	DEC
Massive Open Elective Course (MOOC) – Online Compulsory Course in any one semester from Sem-I to Sem-V									
XXX	MOOC	4/6	0	0	25	75	100	4/6	MOOC
Total Credits								**24**	

SEMESTER - VI

Subject Code	Title	L	T	P	Internal Assessment	End-semester Examination	Total	Credits	Category Code
Discipline Core Course (DCC) – Compulsory 2-Papers									
BPH 601	Electromagnetic Theory	4	0	0	25	75	100	4	DCC
BPH 602	Statistical Mechanics	4	0	0	25	75	100	4	DCC
BPH 603	Electromagnetic Theory Lab	0	0	4	15	35	50	2	DCC
BPH 604	Statistical Mechanics Lab	0	0	4	15	35	50	2	DCC
Discipline Elective Course (DEC) – Select any 2-papers & respective lab (if any) out of the following 3-papers									
DECP 601	Nuclear & Particle Physics	5	1	0	25	75	100	6	DEC
DECP 602	Nano Materials & Applications	4	0	0	25	75	100	4	DEC
DECP 603	Physics of Devices & Communication	4	0	0	25	75	100	6	DEC
DECP 604	Nano Materials & Applications Lab	0	0	4	15	35	50	2	DEC
DECP 605	Physics of Devices & Communication Lab	0	0	4	15	35	50	2	DEC
DECP 606	Classical Dynamics	5	1	0	25	75	100	6	DEC
Total Credits								**24**	

Grand Total Credits: 144/146 [140 + 4/6 (for MOOC Course)]

NOTE: 1. Discipline Elective Course (DEC) papers may be added or deleted as per UGC guidelines.
2. Skill Enhancement Course (SEC) papers may be added or deleted as per UGC guidelines.

Instructions to the students regarding MOOC

1. Two types of courses will be circulated: branch specific and general courses from the website https://swayam.gov.in in the month of June and November every year for the forthcoming semester.
2. The department coordinators will be the course coordinators of their respective departments.
3. Every student has to pass a selected MOOC course within the duration as specified below:

Programme	**Duration**
B. Tech.	Sem. I to Sem. VII
M.Sc./M.Tech./MA/MBA	Sem. I to Sem. III
B.Sc./MCA	Sem. I to Sem. V

The passing of a MOOC course is mandatory for the fulfilment of the award of the degree of concerned programme.

4. A student has to register for the course for which he is interested and eligible which is approved by the department with the help of course coordinator of the concerned department.
5. A student may register in the MOOC course of any programme. However, a UG student will register only in UG MOOC courses and a PG student will register in only PG MOOC courses.
6. The students must read all the instructions for the selected course on the website, get updated with all key dates of the concerned course and must inform his/her progress to their course coordinator.
7. The student has to pass the exam (online or pen-paper mode as the case may be) with at least 25% marks.
8. The students should note that there will be a weightage of Assessment/quiz etc. and final examination appropriately as mentioned in the instructions for a particular course.
9. A student must claim the credits earned in the MOOC course in his/her marksheet in the examination branch by forwarding his/her application through course coordinator and chairperson.

Syllabus of B.Sc. (H) Physics

Semester I

Discipline Core Course (DCC)

B.Sc. (H) Physics Sem-I
Paper: Mathematical Physics
Paper Code: BPH-101

No. of Credits: 4	**Sessional: 25**
L: 4, T: 0	**Theory Exam: 75**
Theory: 60 Lectures	**Total: 100**

COURSE OBJECTIVE
The emphasis of course is on applications in solving problems of interest to physicists. The students are to be examined entirely on the basis of problems based on mathematical physics, seen and unseen.

Calculus:
Plotting of functions. Approximation: Taylor and binomial series (statements only). First Order differential. Equations exact and inexact differential equations and Integrating Factor.
(6 Lectures)

Second Order Differential equations: Homogeneous Equations with constant coefficients. Wronskian and general solution. Particular Integral with operator method, method of undetermined coefficients and variation method of parameters. (15 Lectures)

Vector Algebra: Properties of vectors. Scalar product and vector product, Scalar triple product and their interpretation in terms of area and volume respectively. Scalar and Vector fields.
(6 Lectures)

Vector Calculus:
Vector Differentiation: Directional derivatives and normal derivative. Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field. Del and Laplacian operators. Vector identities. (10 Lectures)

Vector Integration: Ordinary Integrals of Vectors. Multiple integrals, Jacobian. Notion of infinitesimal line, surface and volume elements. Line, surface and volume integrals of Vector fields. Flux of a vector field. Gauss' divergence theorem, Green's and Stokes Theorems and their verification (no rigorous proofs). (14 Lectures)

Orthogonal Curvilinear Coordinates:

Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems. (7 Lectures)

Dirac Delta function:
Definition of Dirac delta function and simple examples. (2 Lectures)

Course Outcomes: After the completion of the course, students will be able to,
- Learn basic ideas of calculus
- Solve vector algebra and vector calculus problems
- Implementation of vector integration for solution of many Physics problems.
- Understand various coordinate systems and Dirac delta functions

Reference Books:

- Mathematical Methods for Physicists, G.B.Arfken, H.J.Weber, F.E.Harris,1513, 7th Edn., Elsevier.
- An introduction to ordinary differential equations, E.A. Coddington, 1509, PHI learning

- Differential Equations, George F. Simmons, 1507, McGraw Hill.
- Advanced Engineering Mathematics, D.G. Zill and W.S.Wright, 5 Ed., 1512, Jones and Bartlett Learning
- Mathematical Physics, Goswami, 1st edition, Cengage Learning
- Engineering Mathematics, S.Pal and S.C. Bhunia, 1515, Oxford University Press
- Advanced Engineering Mathematics, Erwin Kreyszig, 1508, Wiley India.

B.Sc. (H) Physics Sem-I
Paper: Mathematical Physics –I Lab
Paper Code: BPH-103

No. of Credits: 2 **Internal: 15**
L: 0, T: 0, P: 4 **External Exam: 35**
60 Periods **Total: 50**

COURSE OBJECTIVES: The aim of this Lab is not just to teach computer programming and numerical analysis but to emphasize its role in solving problems in Physics.
- Highlights the use of computational methods to solve physics problems
- The course will consist of lectures(both theory and practical) in the Lab
- Evaluation done not on the programming but on the basis of formulating the problem
- Students can use any one operating system Linux or Microsoft Windows
- At least two programs must be attempted from each programming section.

Topics	**Descriptions with Applications**
Errors and error Analysis	Truncation and round-off errors, Absolute and relative errors, Floating point computations

Review of C++ Programming fundamentals	Introduction to Programming, constants, variables and data types, operators and Expressions, I/O statements, cin and cout , Decision making and looping statements *(if-statement, if-else statement, nested if statement, else-if statement, ternary operator, goto statement, switch statement, unconditional and conditional looping, while and do while loop, for loop, nested loops, break and continue statements*). Arrays (1D and 2D) and strings, user defined functions,
Programs: using C++ language	Sum and average of a list of numbers, largest of a given list of numbers and its location in the list, sorting of numbers in ascending descending order, Binary search
Random number generation	Area of circle, area of square, volume of sphere, value of pi
Solution of Algebraic and Transcendental equations by Bisection, Newton Raphson and Secant methods	Solution of linear and quadratic equation, solving $\alpha = \tan \alpha$; $I = I_o (\sin \alpha/\alpha)^2$ in optics,
Interpolation by Newton Gregory Forward and Backward difference formula, Error estimation of linear interpolation	Evaluation of trigonometric functions e.g. $\sin \theta$, $\cos \theta$, $\tan \theta$ etc
Numerical differentiation (Forward and Backward difference formula) and Integration (Trapezoidal and Simpson rules), Monte Carlo Method	Given Position with equidistant time data calculate velocity and acceleration and vice versa. Find the area of BH Hysteresis loop
Solution of Ordinary Differential Equations (ODE) First order Differential equation Euler, modified Euler and Runge-Kutta (RK) second and fourth order methods	First order differential equation • Radioactive decay • Current in RC, LC circuits with DC source • Newton's law of cooling • Classical equations of motion Attempt following problems using RK 4 order method: • Solve the coupled differential equations $dx/dt = y + x - x^3/3$; $dy/dx = - x$ for four initial conditions $x(0) = 0$, $y(0) = -1, -2, -3, -4$. Plot x vs y for each of the four initial conditions on the same screen for $0 \leq t \leq 15$.

Referred Books:

- Introduction to Numerical Analysis, S.S. Sastry, 5th Edn., 1512, PHI Learning Pvt. Ltd.
- Schaum's Outline of Programming with C++. J.Hubbard, 1500 , McGraw-Hill Pub.
- Numerical Recipes in C++: The Art of Scientific Computing, W.H. Press et.al., 2nd Edn., 1513, Cambridge University Press.
- An introduction to Numerical methods in C++, Brian H. Flowers, 1509, Oxford University Press.
- A first course in Numerical Methods, U.M. Ascher & C. Greif, 1512, PHI Learning.
- Elementary Numerical Analysis, K.E. Atkinson, 3rd Edn., 2007, Wiley India Edition.
- Computational Physics, Darren Walker, 1st Edn., 1515, Scientific International Pvt. Ltd.

B.Sc. (H) Physics Sem-I
Paper: Mechanics
Paper Code: BPH-102

No. of Credits: 4	**Sessional: 25**
L: 4, T: 0	**Theory Exam: 75**
Theory: 60 Lectures	**Total: 100**

COURSE OBJECTIVE

The emphasis of course is to understand laws of mechanics and their applications in various physical systems.

Fundamentals of Dynamics: Reference frames. Inertial frames, Review of Newton's Laws of Motion. Galilean transformations. Galilean invariance. Momentum of variable-mass system: motion of rocket. Motion of a projectile in uniform gravitational field. Dynamics of a system of particles. Centre of Mass. Principle of conservation of momentum. Impulse. **(7 Lectures)**

Work and Energy: Work and Kinetic Energy Theorem. Conservative and non-conservative forces. Potential Energy. Energy diagram. Stable and unstable equilibrium. Elastic potential energy. Force as gradient of potential energy. Work & Potential energy. Work done by non-conservative forces. Law of conservation of Energy. **(5 Lectures)**

Collisions: Elastic and inelastic collisions between particles. Centre of Mass and Laboratory frames.**(4 Lectures)**

Rotational Dynamics: Angular momentum of a particle and system of particles. Torque. Principle of conservation of angular momentum. Rotation about a fixed axis. Moment of

Inertia. Calculation of moment of inertia for rectangular, cylindrical and spherical bodies. Kinetic energy of rotation. Motion involving both translation and rotation. **(12 Lectures)**

Elasticity: Review of relation between Elastic constants. Twisting torque on a Cylinder or Wire (only qualitative discussion). **(2 Lectures)**

Gravitation: Law of gravitation. Gravitational potential energy. Inertial & gravitational mass. Potential and field due to spherical shell and solid sphere. **(3 Lectures)**

Central force Motion: Motion of a particle under a central force field. Two-body problem and its reduction to one-body problem and its solution. The energy equation and energy diagram. Kepler's Laws. Satellite in circular orbit & applications, weightlessness and basic idea of Global Positioning System (GPS). **(6 Lectures)**

Oscillations: Review of SHM (Simple Harmonic Oscillations. Differential equation of SHM and its solution. Kinetic energy, potential energy, total energy and their time - average values). Damped oscillation. Forced oscillations: Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor. **(7 Lectures)**

Non-Inertial Systems: Non-inertial frames and fictitious forces. Uniformly rotating frame. Laws of Physics in rotating coordinate systems. Centrifugal force. Coriolis force and its applications. **(4 Lectures)**

Special Theory of Relativity: Michelson-Morley Experiment and its outcome. Postulates of Special Theory of Relativity. Lorentz Transformations. Simultaneity and order of events. Lorentz contraction. Time dilation. Relativistic transformation of velocity, frequency and wave number. Relativistic addition of velocities. Variation of mass with velocity. Massless Particles. Mass-energy Equivalence. Relativistic Doppler effect. Relativistic Kinematics. Transformation of Energy & Momentum. **(10 Lectures)**

Course Outcomes: After the completion of the course, students will be able to,

- Learn fundamentals of Mechanics.
- Have a deep understanding of rotational dynamics & elasticity
- Understand the laws of gravitation and central force motion.
- Have a knowledge of how length, mass and time are relative to the velocity of an event.

Reference Books:

- An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.
- Mechanics, Berkeley Physics, vol.1, C. Kittel, W. Knight, et.al. 1507, Tata McGraw-Hill.
- Physics, Resnick, Halliday and Walker 8/e. 1508, Wiley.
- Analytical Mechanics, G.R. Fowles and G.L. Cassiday. 1505, Cengage Learning.
- Feynman Lectures, Vol.I, R.P.Feynman, R.B.Leighton, M.Sands, 1508, Pearson Education
- Mechanics, D.S. Mathur, S.Chand and Company Limited, 1500.
- Theoretical Mechanics, M.R. Spiegel, 1506, Tata McGraw Hill.

B.Sc. (H) Physics Sem-I
Paper: Mechanics Lab
Paper Code: BPH-104

No. of Credits: 2 | **Internal: 15**
L: 0, T: 0, P: 4 | **External Exam: 35**
60 Periods | **Total: 50**

Select at least 06 experiments from the following

1. To study the random error in observations.
2. To determine the height of a building using a Sextant.
3. To study the Motion of Spring and calculate (a) Spring constant, (b) **g** and (c) Modulus of rigidity.
4. To determine the Moment of Inertia of a Flywheel.
5. To determine **g** and velocity for a freely falling body using Digital Timing Technique
6. To determine the Young's Modulus of a Wire by Optical Lever Method.
7. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
8. To determine the elastic Constants of a wire by Searle's method.
9. To determine the value of g using Bar Pendulum.
10. To determine the value of g using Kater's Pendulum

Reference Books

- Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4^{th} Edition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11^{th} Edn, 1511,Kitab Mahal

Ability Enhancement Compulsory Course (AECC)

Semester- I
Paper: English
Paper Code: BENG-101

No. of Credits: 2 | **Sessional: 25**
L: 2, T: 0, P: 0 | **Theory Exam: 75**
Total: 100

Course Objectives:

1. To discuss communication process and elements of communication with the help of popular models.
2. To discuss types of communication.
3. To improve spoken English and ability to articulate ideas.
4. To improve comprehension
5. To improve formal writing skills.

Unit 1: Introduction: Theory of Communication, Types and modes of Communication

Unit 2: Language of Communication: Verbal and Non-verbal (Spoken and Written) Personal, Social and Business Barriers and Strategies Intra-personal, Inter-personal and Group communication

Unit 3: Speaking Skills: Monologue Dialogue Group Discussion Effective Communication/ Mis-Communication Interview Public Speech

Unit 4: Reading and Understanding Close Reading Comprehension Summary Paraphrasing Analysis and Interpretation Translation(from Indian language to English and vice-versa) Literary/Knowledge Texts

Unit 5: Writing Skills Documenting Report Writing Making notes Letter writing.

Course outcome:

After completion of course students would be able:

1.To learn about communication process and ways to make communication effective by giving attention to all elements involved.

2. To understand the value of verbal communication as well as non- verbal aspects of communication in making inter personnel communication effective and intrapersonnel communication insightful.

3.To gain confidence by enhancing their abilities to articulate their ideas.

4. To able to scan, skim and revise documents for fruitful reading and comprehension.

5. To acquire better writing skills in formal communication.

Recommended References Readings:

1.. Fluency in English - Part II, Oxford University Press, 2006.

2. Business English, Pearson, 2008.

3. Language, Literature and Creativity, Orient Blackswan, 2013.

4. Language through Literature (forthcoming) ed. Dr. Gauri Mishra, Dr Ranjana Kaul, Dr Brati Biswas

Open Elective Courses (OEC)

Semester-I

Open Elective Mathematics

Paper: CALCULUS

Paper Code: OMTH-101

NO. OF CREDITS: 6

		SESSIONAL:	25
L	T	THEORY EXAM:	75
5	1	TOTAL:	100

NOTE: Question paper has two parts. Part-1 has 10 questions each of 2 marks. It covers the entire syllabus. Attempt any four questions out of six from Part-2.

COURSE OBJECTIVES

To gain knowledge about differential calculus, curvature, asymptotes, partial differentiation, maxima-minima of functions of two variables, applications of single integral, double and triple integral.

UNIT I

Definition of limit, Continuity, types of discontinuity, Differentiability, Successive differentiation, Leibnitz's Theorem and applications, Taylor's & Maclaurin's Series for one variable, Asymptotes, Curvature, Radius of Curvature for Cartesian, Parametric and Polar-curves, Radius of curvature at the Origin (by using Newton"s method, by method of Expansion), Centre of curvature, Curve Tracing.

UNIT II

Functions of two or more variables, Partial derivatives of first and higher order, Total differential and differentiability, Euler's theorem for Homogeneous functions, Derivatives of Composite and Implicit functions, Jacobians, Taylor's series for functions of two variables, Maxima-Minima of functions of two variables. Lagrange's Method of undetermined multipliers, Differentiation under the integral sign (Leibnitz rule).

UNIT III

Applications of Single integration to find volume of solids and surface area of solids by revolution, Double integral, Change of Order of Integration, Double integral in Polar co-ordinates, Applications of double integral to find (i) Area enclosed by plane curves (ii) Volume of solids of revolution.

UNIT IV

Triple Integral, Change of variables, Volume of solids, Beta & Gamma functions and relation between them.

COURSE OUTCOMES

- Acquire knowledge about differential calculus
- Acquire knowledge about partial differentiation and maxima-minima of functions of two variables
- Acquire knowledge about integral calculus: application of single integral, double integral and applications
- Acquire knowledge about triple integral and beta and gamma functions

BOOKS RECOMMENDED

- Shanti Narayan, Differential Calculus, S Chand Publisher
- Shanti Narayan, Integral Calculus, S Chand Publisher
- G.B. Thomas and R.L. Finney, Calculus, Pearson Education, 11/e (2012)
- H. Anton, I. Bivens and S. Davis, Calculus, John Willey and Sons Inc, 7/e (2011)

Semester--I

Open Elective Electronics

Paper: Electronic Circuits and PCB Designing

Paper CODE: OELC-101

Credits: Theory-04

			SESSIONAL:	25
L	T		THEORY EXAM:	75
4	0		TOTAL:	100

COURSE OBJECTIVES

To gain knowledge about fundamentals of analog Electronics for its applications in various electronic devices.

Unit-1 (12 Lectures)

Network theorems (DC analysis only): Review of Ohms law, Kirchhoff‘s laws, voltage divider and current divider theorems, open and short circuits.

Thevenin‘s theorem, Norton‘s theorem and interconversion, superposition theorem, maximum power transfer theorem.

Unit 2 (13 Lectures)

Semiconductor Diode and its applications: PN junction diode and characteristics, ideal diode and diode approximations. Block diagram of a Regulated Power Supply, Rectifiers: HWR, FWR-center tapped and bridge FWRs. Circuit diagrams, working and waveforms, ripple factor & efficiency(no derivations).Filters: circuit diagram and explanation of shunt capacitor filter with waveforms.

Zener diode regulator: circuit diagram and explanation for load and line regulation, disadvantages of Zener diode regulator.

Unit-3 (17 Lectures)

BJT and Small Signal amplifier: Bipolar Junction Transistor: Construction, principle & working of NPN transistor, terminology. Configuration: CE, CB, CC. Definition of α, β and γ and their interrelations, leakage currents. Study of CE Characteristics, Hybrid parameters.

Transistor biasing: need for biasing, DC load line, operating point, thermal runaway, stability and stability factor.

Voltage divider bias: circuit diagrams and their working, Q point expressions for voltage divider biasing.

Small signal CE amplifier: circuit, working, frequency response, re model for CE configuration, derivation for Av, Zin and Zout.

Unit-4 (18 Lectures)

Types of PCB: Single sided board, double sided, Multilayer boards, Plated through holes technology, Benefits of Surface Mount Technology (SMT), Limitation of SMT, Surface mount components: Resistors, Capacitor, Inductor, Diode and IC‘s.

Layout and Artwork: Layout Planning: General rules of Layout, Resistance, Capacitance and Inductance, Conductor Spacing, Supply and Ground Conductors, Component Placing and mounting, Cooling requirement and package density, Layout check.

Basic artwork approaches, Artwork taping guidelines, General artwork rules: Artwork check and Inspection.

Laminates and Photoprinting: Properties of laminates, Types of Laminates, Manual cleaning process, Basic printing process for double sided PCB‘s, Photo resists, wet film resists, Coating process for wet film resists, Exposure and further process for wet film resists, Dry film resists

Etching and Soldering: Introduction, Etching machine, Etchant system. Principles of Solder connection, Solder joints, Solder alloys, Soldering fluxes. Soldering, Desoldering tools and Techniques.

COURSE OUTCOMES

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

- Acquire knowledge about Network theorems.
- Learn about **Semiconductor Diode and its applications**
- **Know the working of BJT and Small Signal amplifier**
- Understand the fabrication and circuit designing on **PCB**

Suggested Books:

1. Electronic Devices and circuit theory, Robert Boylstead and Louis Nashelsky, 9th Edition, 2013, PHI
2. Electronics text lab manual, Paul B. Zbar.
3. Electric circuits, Joeseph Edminister, Schaum series.
4. Basic Electronics and Linear circuits, N.N. Bhargava, D.C. Kulshresta and D.C Gupta -TMH.
5. Electronic devices, David A Bell, Reston Publishing Company/DB Tarapurwala Publ.
6. Walter C.Bosshart –PCB DESIGN AND TECHNOLOGY‖ Tata McGraw Hill Publications, Delhi. 1983
7. Clyde F.Coombs –Printed circuits Handbook‖ III Edition, McGraw Hill.

Semester-I
Paper: Electronic Circuits and PCB Designing Lab
Paper Code: OELC-102

Credits: 2

			Internal Exam:	15
L	P	T	External Exam:	35
0	4	0	TOTAL:	50

COURSE OBJECTIVES

Electronic Circuits and PCB Designing Lab (Hardware and Circuit Simulation Software)

1. Verification of Thevenin‘s theorem
2. Verification of Super position theorem
3. Verification of Maximum power transfer theorem.
4. Half wave Rectifier – without and with shunt capacitance filter.
5. Centre tapped full wave rectifier – without and with shunt capacitance filter.
6. Zener diode as voltage regulator – load regulation.
7. Transistor characteristics in CE mode – determination of ri, ro and β.
8. Design and study of voltage divider biasing.
9. Designing of an CE based amplifier of given gain
10. Designing of PCB using artwork, its fabrication and testing.
11. Design, fabrication and testing of a 9 V power supply with zener regulator

Semester-I
Open Elective Chemistry
Paper: Inorganic Chemistry
Paper Code: OCHE-101

Credits: 02

		SESSIONAL:	25
L	T	THEORY EXAM:	75
4	0	TOTAL:	100

Course Objectives: To learn and understand the basic concepts of inorganic chemistry and its role in biological systems.

Unit I

Atomic Structure: *Review of: Bohr's theory and its limitations, Heisenberg Uncertainty principle*.

Dual behaviour of matter and radiation, de-Broglie's relation.Hydrogen atom spectra. Need of a new approach to Atomic structure.

What is Quantum mechanics? Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ^2, Schrödinger equation for hydrogen atom. Radial and angular parts of the hydogenicwavefunctions (atomic orbitals) and theirvariations for

1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Radial and angular nodes and their significance. Radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Significance of quantum numbers, orbital angular momentum and quantum numbers m_l and m_s. Shapes of *s*, *p* and *d* atomic orbitals, nodal planes. Discovery of spin, spin quantum number (*s*) and magnetic spin quantum number(m_s).

Rules for filling electrons in various orbitals, Electronic configurations of the atoms.Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.

Unit II

Chemical Bonding and Molecular Structure

Ionic Bonding*:* General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy (no derivation), Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ioniccharacter.

Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR (H_2O, NH_3, PCl_5, SF_6, ClF_3, SF_4) and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonalbipyramidal and octahedral arrangements.

Concept of resonance and resonating structures in various inorganic and organic compounds. MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for *s-s*, *s-p* and *p-p* combinations of atomic orbitals, nonbonding combination

of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of *s-p* mixing) and heteronuclear diatomic molecules such as CO, NO and NO^+.

Unit III

Organometallic Compounds

Definition and Classification with appropriate examples based on nature of metal-carbon bond (ionic, s, p and multicentre bonds). Structures of methyl lithium, Zeise'ssalt andferrocene. EAN rule as applied to carbonyls. Preparation, structure, bonding and properties of mononuclear and polynuclear carbonyls of 3d metals. p-acceptor behaviour of carbon monoxide. Synergic effects (VB approach)- (MO diagram of CO can be referred to for synergic effect to IRfrequencies).

Unit IV

Bio-Inorganic Chemistry

A brief introduction to bio-inorganic chemistry. Role of metal ions present in biological systems with special reference to Na^+, K^+ and Mg^{+2} ions: Na/K pump; Role of Mg^{+2} ions in energy production and chlorophyll. Role of iron in oxygen transport, haemoglobin, myoglobin, storage and transport of iron.

Course Outcomes:

After the successful completion of the course the learner would be able to

i. Understand the basic concept of atomic structure.
ii. Understand the chemical bonding concept.
iii. Understand the bonding and structure in organometallic compounds.
iv. Understand the role of inorganic chemistry in biological systems.

Reference Books:

- J. D. Lee: *A new Concise Inorganic Chemistry*, E L. B. S.17
- F. A. Cotton & G. Wilkinson: *Basic Inorganic Chemistry*, John Wiley.
- Douglas, McDaniel and Alexader: *Concepts and Models in Inorganic Chemistry*, John Wiley.
- James E. Huheey, *Ellen Keiter and Richard Keiter: Inorganic Chemistry: Principles of Structure and Reactivity*, Pearson Publication.

Semester-I
Open Elective Computer Science
Paper: INTRODUCTION TO PROGRAMMING
Paper Code: OCSE-101

Credits: 04

L	T
4	0

SESSIONAL:	25
THEORY EXAM:	75
TOTAL:	100

Theory: 60 lectures

Course Objectives

1. Be able to explain the difference between object oriented programming and procedural programming.
2. To familiarize students with the features of C language including data-types, variables, Operators ,Functions and Arrays.
3. Be able to program using more advanced C++ features such as composition of objects, operator overloading, dynamic memory allocation, inheritance and polymorphism, file I/O, exception handling, templates etc.
4. Be able to apply object oriented techniques to solve bigger Real World Computing problems.

Introduction to C and C++ 5L

History of C and C++, Overview of Procedural Programming and Object-Orientation Programming, Using main() function, Compiling and Executing Simple Programs in C++.

Data Types, Variables, Constants, Operators and Basic I/O 10L

Declaring, Defining and Initializing Variables, Scope of Variables, Using Named Constants, Keywords, Data Types, Casting of Data Types, Operators (Arithmetic, Logical and Bitwise), Using Comments in programs, Character I/O (getc, getchar, putc, putcharetc), Formatted and Console I/O (printf(), scanf(), cin, cout), Using Basic Header Files (stdio.h, iostream.h, conio.hetc).

Expressions, Conditional Statements and Iterative Statements 10L

Simple Expressions in C++ (including Unary Operator Expressions, Binary Operator Expressions), Understanding Operators Precedence in Expressions, Conditional Statements (if construct, switch-case construct), Understanding syntax and utility of Iterative Statements (while, do-while, and for loops), Use of break and continue in Loops, Using Nested Statements (Conditional as well as Iterative)

Functions and Arrays 10L

Utility of functions, Call by Value, Call by Reference, Functions returning value, Void functions, Inline Functions, Return data type of functions, Functions parameters, Differentiating between Declaration and Definition of Functions, Command Line Arguments/Parameters in Functions, Functions with variable number of Arguments.

Creating and Using One Dimensional Arrays (Declaring and Defining an Array, Initializing an Array, Accessing individual elements in an Array, Manipulating array elements using loops), Use Various types of arrays (integer, float and character arrays / Strings) Two- dimensional Arrays (Declaring, Defining and Initializing Two Dimensional Array, Working with Rows and Columns), Introduction to Multi-dimensional arrays

Derived Data Types (Structures and Unions) 5L

Understanding utility of structures and unions, Declaring, initializing and using simple structures and unions, Manipulating individual members of structures and unions, Array of Structures, Individual data members as structures, Passing and returning structures from functions, Structure with union as members, Union with structures as members.

File I/O, Preprocessor Directives 8L

Opening and closing a file (use of fstream header file, ifstream, ofstream and fstream classes), Reading and writing Text Files, Using put(), get(), read() and write() functions, Random access in files, Understanding the Preprocessor Directives (#include, #define, #error,

#if, #else, #elif, #endif, #ifdef, #ifndef and #undef), Macros

Using Classes in C++ 8L

Principles of Object-Oriented Programming, Defining & Using Classes, Class Constructors, Constructor Overloading, Function overloading in classes, Class Variables &Functions, Objects as parameters, Specifying the Protected and Private Access, Copy Constructors, Overview of Template classes and their use.

Inheritance and Polymorphism 4L

Introduction to Inheritance and Polymorphism

Course Outcomes

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

- **a.** Differentiate between Procedure-Oriented programming and Object-Oriented programming.
- **b.** Understand the syntax of the language.

c. Understand and apply various object oriented features like inheritance, data abstraction, encapsulation and polymorphism to solve various computing problems using C++ language.

d. Apply object oriented concepts in real world programs

Reference Books:

1. Herbtz Schildt, "C++: The Complete Reference", Fourth Edition, McGraw Hill.

2. E Balaguruswamy, "Object Oriented Programming with C++", Tata McGraw-Hill Education, 2008.

3. Paul Deitel, Harvey Deitel, "C++ How to Program", 8^{th} Edition, Prentice Hall, 2011.

4. John R. Hubbard, "Programming with C++", Schaum's Series, 2nd Edition, 2000.

Semester-I

Paper: INTRODUCTION TO PROGRAMMING LAB

Paper Code: OCSE-102

Credits: 2

L	P	T			
			Internal :	15
			External Exam:	35
0	4	0	TOTAL:	50

Introduction to Programming Lab

Practical: 60 lectures

1. Write a program to find greatest of three numbers.
2. Write a program to find gross salary of a person
3. Write a program to find grade of a student given his marks.
4. Write a program to find divisor or factorial of a given number.
5. Write a program to print first ten natural numbers.
6. Write a program to print first ten even and odd numbers.
7. Write a program to find grade of a list of students given their marks.
8. Create Matrix class. Write a menu-driven program to perform following Matrix operations (2-D array implementation):
   a) Sum b) Difference c) Product d) Transpose

Syllabus of B.Sc. (H) Physics

Semester II

Discipline Core Course (DCC)

B.Sc. (H) Physics Sem-II
Paper: ELECTRICITY AND MAGNETISM
Paper Code: BPH-201

No. of Credits: 4	**Sessional: 25**
L: 4, T: 0	**Theory Exam: 75**
Theory: 60 Lectures	**Total: 100**

COURSE OBJECTIVE
The objective of the course is to have an understanding the electricity and magnetism which later on makes the foundation of electromagnetic theory.

Electric Field and Electric Potential

Electric flux. Gauss' Law with applications to charge distributions with spherical, cylindrical and planar symmetry. Conservative nature of Electrostatic Field. Electrostatic Potential. Laplace's and Poisson equations. The Uniqueness Theorem. Potential and Electric Field of a dipole. Force and Torque on a dipole. **(7 Lectures)**

Electrostatic energy of system of charges. Electrostatic energy of a charged sphere. Conductors in an electrostatic Field. Surface charge and force on a conductor. Capacitance of a system of charged conductors. Parallel-plate capacitor. Capacitance of an isolated conductor. Method of Images and its application to: (1) Plane Infinite Sheet and (2) Sphere. **(9 Lectures)**

Dielectric Properties of Matter: Electric Field in matter. Polarization, Polarization Charges. Electrical Susceptibility and Dielectric Constant. Capacitor (parallel plate, spherical, cylindrical) filled with dielectric. Displacement vector **D**. Relations between **E**, **P** and **D**. Gauss' Law in dielectrics. **(9 Lectures)**

Magnetic Field: Ampere's Circuital Law and its application to (1) Solenoid and (2) Toroid. Properties of **B**: curl and divergence. Vector Potential. Magnetic Force on (1) point charge (2) current carrying wire (3) between current elements. Torque on a current loop in a uniform Magnetic Field. **(8 Lectures)**

Magnetic Properties of Matter: Magnetization vector (**M).** Magnetic Intensity(**H).** Magnetic Susceptibility and permeability. Relation between **B, H, M**. Ferromagnetism. B-H curve and hysteresis. **(4 Lectures)**

Electromagnetic Induction: Faraday's Law. Lenz's Law. Self Inductance and Mutual Inductance. Reciprocity Theorem. Energy stored in a Magnetic Field. Introduction to Maxwell's Equations. Charge Conservation and Displacement current. **(6 Lectures)**

Electrical Circuits: AC Circuits: Kirchhoff's laws for AC circuits. Complex Reactance and Impedance. Series LCR Circuit: (1) Resonance, (2) Power Dissipation and (3) Quality Factor, and (4) Band Width. Parallel LCR Circuit. **(7 Lectures)**

Network theorems: Ideal constant-voltage and constant-current Sources. Review of Kirchhoff's Current Law & Kirchhoff's Voltage Law. Mesh & Node Analysis. Thevenin theorem, Norton theorem, Superposition theorem, Reciprocity Theorem, Maximum Power Transfer theorem. Applications to dc circuits.**(10 Lectures)**

Course Outcomes: After the completion of the course, students will be able to,

- Know the basic concepts of electric field and potential
- Understand of dielectric behavior of matter
- Learn the laws of magnetism and electromagnetic induction.
- Have a deep understanding of electrical circuits and network theorems.

Reference Books:

- Electricity, Magnetism & Electromagnetic Theory, S.Mahajan and Choudhury, 1512, Tata McGraw
- Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education
- Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn., 1998, Benjamin Cummings.
- Feynman Lectures Vol.2, R.P.Feynman, R.B.Leighton, M.Sands, 1508, Pearson Education
- Electricity and Magnetism, J.H.Fewkes & J.Yarwood. Vol.I, 1991, Oxford Univ. Press.

B.Sc. (H) Physics Sem-II
Paper: ELECTRICITY AND MAGNETISM Lab
Paper Code: BPH-203

No. of Credits: 2 | **Internal : 15**
L: 0, P: 4, T: 0 | **External Exam: 35**
60 Periods | **Total: 50**

At least 6 experiments from the following

1. To study the characteristics of a series RC Circuit.
2. To determine an unknown Low Resistance using Potentiometer.
3. To determine an unknown Low Resistance using Carey Foster's Bridge.
4. To compare capacitances using De'Sauty's bridge.
5. Measurement of field strength B and its variation in a solenoid (determine dB/dx)
6. To verify the Thevenin and Norton theorems.
7. To verify the Superposition, and Maximum power transfer theorems.
8. To determine self inductance of a coil by Anderson's bridge.
9. To study response curve of a Series LCR circuit and determine its (a) Resonant frequency, (b) Impedance at resonance, (c) Quality factor Q, and (d) Band width.
10. To study the response curve of a parallel LCR circuit and determine its (a) Anti-resonant frequency and (b) Quality factor Q.
11. Measurement of charge sensitivity, current sensitivity and CDR of Ballistic Galvanometer
12. Determine a high resistance by leakage method using Ballistic Galvanometer.
13. To determine self-inductance of a coil by Rayleigh's method.
14. To determine the mutual inductance of two coils by Absolute method.

Reference Books

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
- A Text Book of Practical Physics, I.Prakash &Ramakrishna, 11^{th} Ed., 1511,Kitab Mahal
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4^{th} Edition, reprinted 1985, Heinemann Educational Publishers
- Engineering Practical Physics, S.Panigrahi and B.Mallick, 1515, Cengage Learning.

B.Sc. (H) Physics Sem-II
Paper: Waves & Optics
Paper Code: BPH-202

No. of Credits: 4 — **Sessional: 25**
L: 4, T: 0 — **Theory Exam: 75**
Theory: 60 Lectures — **Total: 100**

COURSE OBJECTIVE

The objective of the course is to have an understanding the of waves and optics which later on makes the foundation of spectroscopy.

Superposition of Collinear Harmonic oscillations: Simple harmonic motion (SHM). Linearity and Superposition Principle. Superposition of two collinear oscillations having

(1) equal frequencies and (2) different frequencies (Beats).Superposition of N collinear Harmonic Oscillations with (1) equal phase differences and (2) equal frequency differences. **(6 Lectures)**

Superposition of two perpendicular Harmonic Oscillations: Graphical and Analytical Methods. Lissajous Figures with equal and unequal frequencies and their uses. **(2 Lectures)**

Wave Motion: Plane and Spherical Waves. Longitudinal and Transverse Waves. Plane Progressive (Travelling) Waves. Wave Equation. Particle and Wave Velocities. Pressure of a Longitudinal Wave. Energy Transport. Intensity of Wave. **(4 Lectures)**

Superposition of Two Harmonic Waves: Standing (Stationary) Waves in a String: Fixed and Free Ends. Analytical Treatment. Phase and Group Velocities. Changes with respect to Position and Time. Energy of Vibrating String. Transfer of Energy. Normal Modes of Stretched Strings. Longitudinal Standing Waves and Normal Modes. **(8 Lectures)**

Interference: : Definition and properties of wave front. Huygens Principle. Temporal and Spatial Coherence. Division of amplitude and wavefront. Young's double slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment.

Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: Measurement of wavelength and refractive index. **(14 Lectures)**

Interferometer: Michelson Interferometer-(1) Idea of form of fringes (No theory required), (2) Determination of Wavelength, (3) Wavelength Difference, (4) Refractive Index, and (5) Visibility of Fringes. Fabry-Perot interferometer. **(6 Lectures)**

Fraunhofer diffraction: Single slit. Rectangular and Circular aperture, Resolving Power of a telescope. Double slit. Multiple slits. Diffraction grating. Resolving power of grating. (10 Lectures)

Fresnel Diffraction: Fresnel's Assumptions. Fresnel's Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Fresnel's Integral, Cornu`s spiral and its applications. Straight edge, a slit and a wire. **(10 Lectures)**

Course Outcomes: After the completion of the course, students will be able to,

- Understand the superposition of linear and perpendicular oscillations.
- Learn the basics of wave motion and SHM.
- Analyze interference phenomena in various systems.
- Know the phenomenon of Diffraction of light in various systems.

Reference Books

- Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 1507, Tata McGraw-Hill.
- Fundamentals of Optics, F.A. Jenkins and H.E. White, 1981, McGraw-Hill
- Principles of Optics, Max Born and Emil Wolf, 7th Edn., 1999, Pergamon Press.
- Optics, Ajoy Ghatak, 1508, Tata McGraw Hill
- The Physics of Vibrations and Waves, H. J. Pain, 1513, John Wiley and Sons.
- The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.
- Fundamental of Optics, A. Kumar, H.R. Gulati and D.R. Khanna, 1511, R. Chand Publications

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B.Sc. (H) Physics Sem-II
Paper: Waves & Optics Lab
Paper Code: BPH-204

No. of Credits: 2	**Internal: 15**
L: 0, T: 0, P: 4	**External Exam: 35**
60 Periods	**Total: 50**

At least 6 experiments from the following

1. To determine the frequency of an electric tuning fork by Melde's experiment and verify λ^2 –T law.
2. To investigate the motion of coupled oscillators.
3. To study Lissajous Figures.
4. Familiarization with: Schuster`s focusing; determination of angle of prism.
5. To determine refractive index of the Material of a prism using sodium source.

6. To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.
7. To determine the wavelength of sodium source using Michelson's interferometer.
8. To determine wavelength of sodium light using Fresnel's Biprism.
9. To determine wavelength of sodium light using Newton's Rings.
10. To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film.
11. To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating.
12. To determine dispersive power and resolving power of a plane diffraction grating.

Reference Books

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 1511,Kitab Mahal
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal,1985, Vani Pub.

Ability Enhancement Compulsory Course (AECC)

Semester- II

Environmental Science

Paper Code: BEVS- 101

No. of Credits: 2	**Internal: 25**
L: 2, T: 0, P: 0	**External Exam: 75**
	Total: 100

Unit 1 : Introduction to environmental studies

- Multidisciplinary nature of environmental studies;
- Scope and importance; Concept of sustainability and sustainable development.

Unit 2 : Ecosystems

- What is an ecosystem? Structure and function of ecosystem; Energy flow in an ecosystem: food chains, food webs and ecological succession. Case studies of the following ecosystems :
  a) Forest ecosystem
  b) Grassland ecosystem
  c) Desert ecosystem
  d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Unit 3 : Natural Resources : Renewable and Non-renewable Resources

- Land resources and landuse change; Land degradation, soil erosion and desertification.
- Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations.
- Water : Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter-state).
- Energy resources : Renewable and non renewable energy sources, use of alternate energy sources, growing energy needs, case studies.

Unit 4 : Biodiversity and Conservation

- Levels of biological diversity : genetic, species and ecosystem diversity; Biogeographic zones of India; Biodiversity patterns and global biodiversity hot spots
- India as a mega-biodiversity nation; Endangered and endemic species of India
- Threats to biodiversity : Habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions; Conservation of biodiversity : In-situ and Ex-situ conservation of biodiversity.
- Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value.

Unit 5 : Environmental Pollution

- Environmental pollution : types, causes, effects and controls; Air, water, soil and noise pollution
- Nuclear hazards and human health risks

- Solid waste management : Control measures of urban and industrial waste.
- Pollution case studies.

Unit 6 : Environmental Policies & Practices

- Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture
- Environment Laws: Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act. International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD).
- Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context.

Unit 7 : Human Communities and the Environment

- Human population growth: Impacts on environment, human health and welfare.
- Resettlement and rehabilitation of project affected persons; case studies.
- Disaster management : floods, earthquake, cyclones and landslides.
- Environmental movements : Chipko, Silent valley, Bishnois of Rajasthan.
- Environmental ethics: Role of Indian and other religions and cultures in environmental conservation.
- Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi).

Unit 8 : Field work

- Visit to an area to document environmental assets: river/ forest/ flora/fauna, etc.
- Visit to a local polluted site-Urban/Rural/Industrial/Agricultural.
- Study of common plants, insects, birds and basic principles of identification.

Reference Books

1. Odum, E.P., Odum, H.T. & Andrews, J. 1971. *Fundamentals of Ecology*. Philadelphia: Saunders.
2. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2011. Environmental and Pollution Science. Academic Press.
3. Rao, M.N. & Datta, A.K. 1987. *Waste Water Treatment*. Oxford and IBH Publishing Co. Pvt. Ltd.
4. Sengupta, R. 2003. *Ecology and economics*: An approach to sustainable development. OUP.
5. Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. *Ecology, Environmental Science and Conservation*. S. Chand Publishing, New Delhi.
6. Sodhi, N.S., Gibson, L. & Raven, P.H. (eds). 2013. *Conservation Biology*: *Voices from the Tropics*. John Wiley & Sons.

Open Elective Courses (OEC)

Semester-II
Open Elective Mathematics
Paper: Linear Algebra
CODE: OMTH 201

L	T	SESSIONAL:	25
		THEORY EXAM:	75
5	1	TOTAL:	100

Total: 60 periods

COURSE OBJECTIVES

The aim of the course is to familiarize students with the concept of a Linear Transformation and its algebraic properties and the manipulative techniques necessary to use matrices and

determinants in solving applied problems. This course in linear algebra serves as a bridge from the typical intuitive treatment of calculus to more rigorous courses such as abstract algebra and analysis.

UNIT-I

Fundamental operation with vectors in Euclidean space $\mathbf{R}^n$, Linear combination of vectors, Dot product and their properties, Cauchy-Schwarz inequality, Triangle inequality, Projection of vectors, Some elementary results on vector in $\mathbf{R}^n$, Matrices, Echelon matrices, Row canonical form , Row equivalence, Rank, Linear combination of vectors, Row space, Eigenvalues, Eigenvectors, Eigenspace, Characteristic polynomials.

UNIT-II

Diagonalization of matrices. Definition and examples of vector space, Some elementary properties of vector spaces, Subspace, Span of a set, A spanning set for an eigenspace, Linear independence and linear dependence of vectors, Maximal linearly independent sets, Minimal spanning sets, Basis and dimension of a vector space.

UNIT-III

Application of rank, Homogenous and non homogenous systems of equations, Coordinates of a vector in ordered basis, Transition matrix .

Linear transformations: Definition and examples, Elementary properties, The matrix of a linear transformation, Linear operator and Similarity, Kernel and range of a linear transformation.

UNIT-IV

Dimension theorem, Oneto one and onto linear transformations, Invertible linear transformations. Isomorphism: Isomorphic vector spaces (to $\mathbf{R}^n$), Orthogonal and orthonormal vectors, Orthogonal and orthonormal bases, Orthogonal complement, Projection theorem (Statement only), Orthogonal projection onto a subspace.

COURSE OUTCOMES

After successful completion of the course students should be able to :

- Gauss–Jordan row reduction, Reduced row echelon form .
- Locate and use information to solve problems of linear transformations and vector spaces;
- Describe the concept of linear independence, linear transformation anddeterminants;
- Find eigenvalues and eigen vectors and Diagonalization of matrices.
- How to find Orthogonal and orthonormal bases

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Books Recommended:

[1] S. Andrilli and D. Hecker, Elementary Linear Algebra, Academic Press, 4/e (2012)
[2] B. Kolman and D.R. Hill, Introductory Linear Algebra with Applications, Pearson Education, 7/e (2003)

Semester-II

Open Elective Computer Science

Paper: Introduction to Database System

Paper Code: OCSC 201

Lecture 04, Tutorial :0	**Internal Assessment: 25**
Credit: 4	**End-semester Examination: 75**
Total Lectures: 60	**Total: 100**

Course Objectives:

1. The students will be able to understand basic terminology used in database systems, basic concepts, the applications of database systems and understand role of Database administrator in DBMS.
2. The students will be able to understand various data model like Hierarchical model, Network Model, Relational model, E-R model and will be able to make E-R diagram from data given by user and table from E-R diagram.
3. The students will be familiar with relational database theory and be able to write relational algebra expressions for query.
4. The students will be able to understand the logical design guidelines for databases, normalization approach, primary key, super key, foreign key concepts

Database: Introduction to database, relational data model, DBMS architecture, data independence, DBA, database users, end users, front end tools

E-R Modeling: Entity types, entity set, attribute and key, relationships, relation types, E- R diagrams, database design using ER diagrams

Relational Data Model: Relational model concepts, relational constraints, primary and foreign key, normalization: 1NF, 2NF, 3NF

Structured Query Language: SQL queries, create a database table, create relationships between database tables, modify and manage tables, queries, forms,

reports, modify, filter and view data.

Course Outcomes

The Student will be able

1. To understand the basic concepts, applications and architecture of database systems.
2. To master the basics of ER diagram.
3. To understand relational database algebra expressions and construct queries using SQL.
4. To understand sound design principles for logical design of databases, normalization.

Reference Books for Introduction to Database System

5. Fundamentals of Database Systems by R. Elmasri and S.B. Navathe, 3rd edition, 2000, Addision-Wesley, Low Priced Edition.
6. An Introduction to Database Systems by C.J. Date, 7th edition, Addison-Wesley, Low Priced Edition, 2000.
7. Database Management and Design by G.W. Hansen and J.V. Hansen, 2nd edition, 1999, Prentice-Hall of India, Eastern Economy Edition.
8. Database Management Systems by A.K. Majumdar and P. Bhattacharyya, 5th edition, 1999, Tata McGraw-Hill Publishing.
9. A Guide to the SQL Standard, Date, C. and Darwen,H. 3rd edition, Reading, MA: 1994, Addison-Wesley.
10. Data Management & file Structure by Loomis, 1989, PHI
11. P. Rob, C. Coronel, Database System Concepts by, Cengage Learning India, 2008

Semester-II
Subject: Introduction to Database System Lab
Subject Code: OCSC 202

L:0, T:0, P:4 | **Internal Assessment: 15**
Credit: 2 | **End-semester Examination: 35**
Total: 50

1) Create a database having two tables with the specified fields, to computerize a library system of a Delhi University College.

LibraryBooks (Accession number, Title, Author, Department, PurchaseDate, Price)
IssuedBooks (Accession number, Borrower)

a) Identify primary and foreign keys. Create the tables and insert at least 5 records in each table.

b) Delete the record of book titled “Database System Concepts”.

c) Change the Department of the book titled “Discrete Maths” to “CS”.

d) List all books that belong to “CS” department.

e) List all books that belong to “CS” department and are written by author “Navathe”.

f) List all computer (Department=”CS”) that have been issued.

g) List all books which have a price less than 500 or purchased between “01/01/1999” and “01/01/2004”.

2) Create a database having three tables to store the details of students of Computer Department in your college.

Personal information about Student (College roll number, Name of student, Date of birth, Address, Marks(rounded off to whole number) in percentage at 10 + 2, Phone number)

Paper Details (Paper code, Name of the Paper)

Student’s Academic and Attendance details (College roll number, Paper code, Attendance, Marks in home examination).

a) Identify primary and foreign keys. Create the tables and insert at least 5 records in each table.

b) Design a query that will return the records (from the second table) along with the name of student from the first table, related to students who have more than 75% attendance and more than 60% marks in paper 2.

c) List all students who live in “Delhi” and have marks greater than 60 in paper1. d) Find the total attendance and total marks obtained by each student.

e) List the name of student who has got the highest marks in paper2

3) Create the following tables and answer the queries given below:

Customer (CustID, email, Name, Phone, ReferrerID)

Bicycle (BicycleID, DatePurchased, Color, CustID, ModelNo)
BicycleModel (ModelNo, Manufacturer, Style)

Service (StartDate, BicycleID, EndDate)

a) Identify primary and foreign keys. Create the tables and insert at least 5 records in each table.

b) List all the customers who have the bicycles manufactured by manufacturer "Honda". c) List the bicycles purchased by the customers who have been referred by customer "C1".

d)List the manufacturer of red colored bicycles.

e)List the models of the bicycles given for service.

4) Create the following tables, enter at least 5 records in each table and answer the queries given below.

EMPLOYEE (Person_Name, Street, City)

WORKS (Person_Name, Company_Name, Salary)
COMPANY (Company_Name, City)

MANAGES (Person_Name, Manager_Name)

a)Identify primary and foreign keys.

b)Alter table employee, add a column "email" of type varchar(20).

c)Find the name of all managers who work for both Samba Bank and NCB Bank.

d) Find the names, street address and cities of residence and salary of all employees who work for "Samba Bank" and earn more than $10,000.

e) Find the names of all employees who live in the same city as the company for which they work.

f) Find the highest salary, lowest salary and average salary paid by each company.

g) Find the sum of salary and number of employees in each company.h) Find the name of the company that pays highest salary.

5) Create the following tables, enter at least 5 records in each table and answer the queries given below.

Suppliers (SNo, Sname, Status, SCity) Parts (PNo, Pname, Colour, Weight, City) Project (JNo, Jname, Jcity)

Shipment (Sno, Pno, Jno, Qunatity)

a) Identify primary and foreign keys.

b) Get supplier numbers for suppliers in Paris with status>20.

c) Get suppliers details for suppliers who supply part P2. Display the supplier list in increasing order of supplier numbers.

d) Get suppliers names for suppliers who do not supply part P2.

e) For each shipment get full shipment details, including total shipment weights. f) Get all the shipments where the quantity is in the range 300 to 750 inclusive.

g) Get part nos. for parts that either weigh more than 16 pounds or are supplied by suppliers S2, or both.

h) Get the names of cities that store more than five red parts.

i) Get full details of parts supplied by a supplier in London.

j) Get part numbers for part supplied by a supplier in London to a project in London. k) Get the total number of project supplied by a supplier (say, S1).

l) Get the total quantity of a part (say, P1) supplied by a supplier (say, S1)

Semester-II
Open Elective Chemistry
Paper: Physical Chemistry
Paper Code: OCHE 201

L-04 T-00
Credit: 4
Theory: 60 periods

Internal Assessment: 25
End-semester Examination: 75
Total Marks: 100

Course Objectives: To learn and understand the elements of physical chemistry and physical phenomenon.

Unit I
Chemical Energetics

Review of thermodynamics and the Laws of Thermodynamics.

Important principles and definitions of thermochemistry.Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution.Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data.Variation of enthalpy of a reaction with temperature – Kirchhoff's equation.Statement of Third Law of thermodynamics and calculation of absolute entropies of substances.

Unit I.

Chemical Equilibrim:

Free energy change in a chemical reaction.Thermodynamic derivation of the law of chemical equilibrium.Distinction between*G* and *G*o, Le Chatelier's principle. Relationships between*Kp*, *Kc*and *Kx*for reactions involving ideal gases.

Ionic Equilibria:

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts.Buffer solutions.Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

Unit III

Solutions

Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law – non-ideal solutions. Vapour pressure-composition and temperature- composition curves of ideal and non-ideal solutions. Distillation of solutions.Lever rule.Azeotropes.Partial miscibility of liquids: Critical solution temperature; effect of impurity on partial miscibility of liquids. Immiscibility of liquids- Principle of steam distillation.Nernst distribution law and its applications, solvent extraction.

Phase Equilibrium

Phases, components and degrees of freedom of a system, criteria of phase equilibrium.Gibbs Phase Rule and its thermodynamic derivation. Derivation of Clausius – Clapeyron equation and its importance in phase equilibria. Phase diagrams of one-componentsystems (water and sulphur) and two component systems involving eutectics, congruent and incongruent melting points (lead- silver, FeCl3-H2O and Na-Konly).

Unit IV

Electrochemistry

Reversible and irreversible cells.Concept of EMF of a cell.Measurement of EMF of a cell.Nernst equation and its importance.Types of electrodes.Standard electrode potential.Electrochemical series. Thermodynamics of a reversible cell, calculation of thermodynamic properties: *G*, *H* and *S* from EMFdata.Calculation of equilibrium constant from EMF data. Concentration cells with transference and without transference. Liquid junction potential and salt bridge.pH determination using hydrogen electrode and quinhydrone electrode.Potentiometric titrations -qualitative treatment (acid-base and oxidation-reduction only).

Course Outcomes:

After the successful completion of the course the learner would be able to

I. Understand the basic concept chemical thermodynamics
II. Understand chemical ionic equilibrium
III. Understand phase equilibrium
IV. Understand electrochemistry.

Reference Books

G. M. Barrow: *Physical Chemistry* Tata McGraw Hill (2007).
G. W. Castellan: *Physical Chemistry* 4th Edn. Narosa (2004).
J. C. Kotz, P. M. Treichel& J. R. Townsend: *General Chemistry* CengageLening India Pvt. Ltd., New Delhi (2009).
B. H. Mahan: *University Chemistry* 3rd Ed. Narosa (1998).
R. H. Petrucci: *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).

Syllabus of B.Sc. (H) Physics

Semester III

Discipline Core Course (DCC)

B.Sc.(H) Physics Sem-III
Paper: Mathematical Physics-II
Paper Code: BPH-301

No. of Credits: 4 | **Sessional: 25**
L: 4, T: 0 | **Theory Exam: 75**
Theory: 60 Lectures | **Total: 100**

Course objectives:
The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.

Fourier Series: Periodic functions. Orthogonality of sine and cosine functions, Dirichlet Conditions (Statement only). Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients. Even and odd functions and their Fourier expansions. Application. Summing of Infinite Series. Term-by-Term differentiation and integration of Fourier Series. Parseval Identity. (15 Lectures)

Power Series (Frobenius) Method and Special Functions: Singular Points of Second Order Linear Differential Equations and their importance. Frobenius method and its applications to differential equations. Legendre, Bessel, Hermite and Laguerre Differential Equations. Properties of Legendre Polynomials: Rodrigues Formula, Generating Function, Orthogonality. Simple recurrence relations.Expansion of function in a series of Legendre Polynomials. Bessel Functions of the First Kind: Generating Function, simple recurrence relations. Zeros of Bessel Functions ($J_o(x)$ and $J_1(x)$) and Orthogonality. (24 Lectures)

Some Special Integrals: Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. (6 Lectures)

Partial Differential Equations: Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular geometry.
Solution of wave equation for vibrational modes of a stretched string, rectangular and circular membranes. (15 Lectures)

Course Outcomes: After the completion of the course, students will be able to,

- Learn to analyze various complex functions in Fourier Series

- Solve LDE by power series method
- Learn various special functions for solution of many Physics problems.
- Learn special integral by Beta and Gamma functions.
- Understand to solve PDE used in many Physics problems.

Reference Books:

Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier. Fourier Analysis by M.R. Spiegel, 2004, Tata McGraw-Hill.
Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole. Differential Equations, George F. Simmons, 2006, Tata McGraw-Hill.
Engineering Mathematics, S.Pal and S.C. Bhunia, 2015, Oxford University Press

Mathematical methods for Scientists & Engineers, D.A.McQuarrie, 2003, Viva Books

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B.Sc.(H) Physics Sem-III
Paper: Mathematical Physics-II Lab
Paper Code: BPH-304

No. of Credits: 2 **Sessional: 15**
L: 0, T: 0, P: 4 **External Exam: 35**
Lab: 60 Periods **Total: 50**

Course Objectives: *The aim of this Lab is to use the computational methods to solve physical problems. The course will consist of lectures (both theory and practical) in the Computer Lab. Evaluation done not on the basis of programming but on the basis of formulating the problem. At least two programs must be attempted from each programming section.*

Topics	**Description with Applications**
Introduction to Numerical computation software Scilab	Introduction to Scilab, Advantages and disadvantages, Scilab environment, Command window, Figure window, Edit window, Variables and arrays, Initialising variables in Scilab, Multidimensional arrays, Sub-array, Special values, Displaying output data, data file, Scalar and array operations, Hierararchy of operations, Built in Scilab functions, Introduction to plotting, 2D and 3D plotting, Branching Statements and program design, Relational and logical operators, the while loop, for loop, details of loop operations, break and continue statements, nested loops, logical arrays and vectorization. User defined functions, Introduction to Scilab functions, Variable

	passing in Scilab, optional arguements, preserving data between calls to a function, Complex and Character data, String function, Multidimensional arrays an introduction to Scilab file processing, file opening and closing, Binary I/o functions, comparing binary and formatted functions, Numerical methods and developing the skills of writing a program.
Curve fitting, Least square fit, Goodness of fit, standard deviation using Scilab	Ohms law calculate R, Hookes law, Calculate spring constant, Given Bessel's function at N points find its value at an intermediate point
Solution of Linear system of equations by Gauss elimination method and Gauss Seidal method. Diagonalisation of matrices, Inverse of a matrix, Eigen vectors, eigen-values problems	Solution of mesh equations of electric circuits (3 meshes) Solution of coupled spring mass systems (3 masses)
Generation of Special functions using User defined functions in Scilab	Generating and plotting Legendre Polynomials Generating and plotting Bessel function
Solution of ODE First order Differential equation Euler, modified Euler and Runge-Kutta (RK) second and Fourth order methods Second order differential equation Fixed difference method Partial differential equations	First order differential equation: • Radioactive decay • Current in RC, LC circuits with DC source • Newton's law of cooling • Classical equations of motion Second order Differential Equation: • Harmonic oscillator (no friction) • Damped Harmonic oscillator (Overdamped, Critical damped, Oscillatory) • Forced Harmonic oscillator (Transient and Steady state solution) • Apply above to LCR circuits also Partial Differential Equation: • Wave equation • Heat equation • Poisson equation • Laplace equation
Using Scicos/xcos	• Generating sine wave, square wave, sawtooth wave • Solution of harmonic oscillator • Study of heat phenomenon • Phase space plots

Reference Books:

- Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press
- A Guide to MATLAB, B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, 2014, 3rd Edn., Cambridge University Press
- Getting started with Matlab, Rudra Pratap, 2010, Oxford University Press.
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A.V. Wouwer, P. Saucez, C.V. Fernández. 2014 Springer

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B.Sc.(H) Physics Sem-III
Paper: Thermal Physics
Paper Code: BPH-302

No. of Credits: 4	**Sessional: 25**
L: 4, T: 0	**Theory Exam: 75**
Theory: 60 Lectures	**Total: 100**

COURSE OBJECTIVE
The objective of the course is to have deep understanding the thermodynamics which later on makes the foundation for statistical Mechanics.

Introduction to Thermodynamics
Zeroth and First Law of Thermodynamics: Extensive and intensive Thermodynamic Variables, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics & Concept of Temperature, Concept of Work & Heat, State Functions, First Law of Thermodynamics and its differential form, Internal Energy, First Law & various processes, Applications of First Law: General Relation between C_P and C_V, Work Done during Isothermal and Adiabatic Processes (8 Lectures)

Second Law of Thermodynamics: Reversible and Irreversible process with examples. Conversion of Work into Heat and Heat into Work. Heat Engines. Carnot's Cycle, Carnot engine & efficiency. Refrigerator & coefficient of performance, 2nd Law of Thermodynamics: Kelvin-Planck and Clausius Statements. Carnot's Theorem. Applications of Second Law of Thermodynamics: Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale. (10 Lectures)

Entropy: Concept of Entropy, Second Law of Thermodynamics in terms of Entropy. Entropy of a perfect gas. Principle of Increase of Entropy. Entropy Changes in Reversible and Irreversible processes with examples. Entropy of the Universe. Entropy Changes in Reversible and Irreversible Processes. Temperature–Entropy diagrams for Carnot's Cycle. Third Law of Thermodynamics. Unattainability of Absolute Zero. (7 Lectures)

Thermodynamic Potentials: Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy. Their Definitions, Properties and Applications, First and second order Phase Transitions with examples, Clausius Clapeyron Equation (7 Lectures)

Maxwell's Thermodynamic Relations: Derivation of Maxwell's thermodynamic Relations and their applications, Maxwell's Relations: (1) Clausius Clapeyron equation, (2) Value of C_p-C_v, (3) TdS Equations, (4) Energy equations. (7 Lectures)

Kinetic Theory of Gases

Distribution of Velocities: Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy (No proof required). Specific heats of Gases. (7 Lectures)

Molecular Collisions: Mean Free Path. Collision Probability. Estimation of Mean Free Path. Transport Phenomenon in Ideal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion. Brownian Motion and its Significance. (4 Lectures)

Real Gases: Behavior of Real Gases: Deviations from the Ideal Gas Equation. Andrew's Experiments on CO_2 Gas. Critical Constants. Continuity of Liquid and Gaseous State. Vapour and Gas. Boyle Temperature. van der Waal's Equation of State for Real Gases. Values of Critical Constants. P-V Diagrams. Free Adiabatic Expansion of a Perfect Gas. Joule-Thomson Porous Plug Experiment. Joule-Thomson Effect for Real and van der Waal Gases. Temperature of Inversion. Joule-Thomson Cooling. (10 Lectures)

Course Outcomes: After the completion of the course, students will be able to,

- Know the basic laws of thermodynamics
- Understand of concept of entropy
- Learn various thermodynamic potentials and Maxwell's thermodynamic relations.
- Have an understanding of the kinetic theory of gases.
- Learn the behaviour of Real gases

Reference Books:

- Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill.
- A Treatise on Heat, Meghnad Saha, and B.N.Srivastava, 1958, Indian Press
- Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill
- Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa.
- Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. Chand Publications.

B.Sc.(H) Physics Sem-III
Paper: Thermal Physics Lab
Paper Code: BPH-305

No. of Credits: 2
L: 0, P: 4
Lab: 60 Periods

Sessional: 15
External Exam: 35
Total: 50

At least 5 experiments from the following

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.

2. To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus.

3. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.

4. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method.

5. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT).

6. To study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of its Two Junctions.

7. To calibrate a thermocouple to measure temperature in a specified Range using

(1) Null Method, (2) Direct measurement using Op-Amp difference amplifier and
to determine Neutral Temperature.

Reference Books:

- Advanced Practical Physics for students, B. L. Flint and H.T.Worsnop, 1971, Asia Publishing House
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011,Kitab Mahal Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal,1985, Vani Pub.

B.Sc.(H) Physics Sem-III
Paper: ANALOG SYSTEMS AND APPLICATIONS
Paper Code: BPH-303

No. of Credits: 4 | **Sessional: 25**
L: 4, T: 0 | **Theory Exam: 75**
Theory: 60 Lectures | **Total: 100**

COURSE OBJECTIVE
The objective of the course is to have an understanding basic semiconductor physics and electronic devices which has a wide range of applications in science & technology.

Semiconductor Diodes: P and N type semiconductors. Energy Level Diagram. Conductivity and Mobility, Concept of Drift velocity.PN Junction Fabrication (Simple Idea). Barrier Formation in PN Junction Diode. Derivation of Barrier Potential, Barrier Width and Current for abrupt Junction. Current Flow Mechanism in Forward and Reverse Biased Diode. (9 Lectures)

Two-terminal Devices and their Applications: (1) Rectifier Diode: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, C-filter, (2) Zener Diode and Voltage Regulation. Principle, structure and characteristics of (1) LED, (2) Photodiode and (3) Solar Cell. (8 Lectures)

Bipolar Junction transistors: n-p-n and p-n-p Transistors. I-V characteristics of CB and CE Configurations. Active, Cut off and Saturation Regions. Current gains α and β. Relations between α and β. Load Line analysis of Transistors. DC Load line and Q-point. Physical Mechanism of Current Flow. (8 Lectures)

Amplifiers: Transistor Biasing and Stabilization Circuits. Fixed Bias and Voltage Divider Bias. Transistor as 2-port Network, h-parameter Equivalent Circuit. Analysis of a single-stage CE amplifier using Hybrid Model. Input and Output Impedance. Current, Voltage and Power Gains. Classification of Class A, B & C Amplifiers. Two stage RC-coupled amplifier and its frequency response. (13 Lectures)

Feedback in Amplifiers: Positive and Negative Feedback. Effect of negative feedback on Input Impedance, Output Impedance, Gain, Stability, Distortion, Noise and band width. (4 Lectures)
Sinusoidal Oscillators: Barkhausen's Criterion for self-sustained oscillations. RC Phase shift oscillator, determination of Frequency.Hartley & Colpitts oscillators. (7 Lectures)

Operational Amplifiers (Black Box approach) & its applications : Characteristics of an Ideal and Practical Op-Amp. (IC 741) Open-loop and Closed-loop Gain. Frequency Response. CMRR. Slew Rate and concept of Virtual ground. Applications of Op-Amps: (1) Inverting and non-inverting amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator, (5) Integrator, (6) Log amplifier, (7) Comparator and Zero crossing detector (10 Lectures)

Conversion: D/A Resistive networks (Weighted and R-2R Ladder). A/D conversion, Accuracy and Resolution. (5 Lectures)

Course Outcomes: After the completion of the course, students will be able to,

- Know the basics of Semiconductor physics and P-N diode and rectifiers and filters.
- Understand the characteristics of BJT in various configurations.
- Learn the process of amplification and feedback in amplifiers.
- Have an understanding of the physics of Op-Amp and its applications .

Reference Books:

- Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
- Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
- Solid State Electronic Devices, B.G.Streetman & S.K.Banerjee, 6th Edn.,2009, PHI Learning
- Electronic Devices & circuits, S.Salivahanan & N.S.Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill
- OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall
- Microelectronic circuits, A.S. Sedra, K.C. Smith, A.N. Chandorkar, 2014, 6th Edn., Oxford University Press.
- Semiconductor Devices: Physics and Technology, S.M. Sze, 2nd Ed., 2002, Wiley India.
- Microelectronic Circuits, M.H. Rashid, 2nd Edition, Cengage Learning
- Microelectronic Devices & Circuits, David A.Bell, 5th Edn.,2015, Oxford University Press

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B.Sc.(H) Physics Sem-III
Paper: ANALOG SYSTEMS AND APPLICATIONS Lab
Paper Code: BPH-306

No. of Credits: 2	**Sessional: 15**
L: 0, P: 4	**External Exam: 35**
Lab: 60 Periods	**Total: 50**

At least 08 experiments from the following:

1. To study the V-I characteristics of a Zener diode and its use as voltage regulator.

2. Study of V-I & power curves of solar cells, and find maximum power point & efficiency.

3. To study the characteristics of a Bipolar Junction Transistor in CE configuration.

4. To study the various biasing configurations of BJT for normal class A operation.
5. To design a CE transistor amplifier of a given gain (mid-gain) using voltage divider bias.

6. To study the frequency response of voltage gain of a two stage RC-coupled transistor amplifier.

7. To design a Wien bridge oscillator for given frequency using an op-amp.

8. To design a phase shift oscillator of given specifications using BJT.

9. To design a digital to analog converter (DAC) of given specifications.

10. To design an inverting amplifier using Op-amp (741, 351) for dc voltage of given gain

11. (a) To design inverting amplifier using Op-amp (741, 351) & study its frequency response

    (b) To design non-inverting amplifier using Op-amp (741, 351) & study frequency response

12. (a) To add two dc voltages using Op-amp in inverting and non-inverting mode

    (b) To study the zero-crossing detector and comparator.

13. To design a precision Differential amplifier of given I/O specification using Op-amp.

14. To investigate the use of an op-amp as an Integrator.

15. To investigate the use of an op-amp as a Differentiator.

16. To design a circuit to simulate the solution of simultaneous equation and $1^{st}/2^{nd}$order differential equation.

Reference Books:

- Basic Electronics: A text lab manual, P.B.Zbar, A.P.Malvino, M.A.Miller, 1994, Mc-Graw Hill.
- OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4^{th} edition, 2000, Prentice Hall.
- Electronic Principle, Albert Malvino, 2008, Tata Mc-Graw Hill.
- Electronic Devices & circuit Theory, R.L.Boylestad & L.D.Nashelsky, 2009, Pearson

Open Elective Courses (OEC)

Semester-III
Open Elective Computer Science
Paper: Computer Networks and Internet Technologies
Paper Code: OCSC-301

Credits: 04

		SESSIONAL:	25
L	T	THEORY EXAM:	75
4	0	TOTAL:	100

Theory: 60 lecture

Course Objectives:

1. The students will be able to understand basic computer network technology, different types of network topologies and protocols.
2. The students will be able to enumerate the layers of the OSI model and TCP/IP and analyze the services and features of the various layers of data networks.
3. The students will be able to learn services and protocols of physical and data link layer and understand IEEE 802 standards.
4. The students will be able to understand and building the skills of subnetting and routing mechanisms. Design, calculate, and apply subnet masks and addresses to fulfill networking requirements.
5. The students will be able to understand Internet Terms , Internet Applications and understand basics of HTML and JavaScript

Computer Networks: Introduction to computer network, data communication, components of data communication, data transmission mode, data communication measurement, LAN, MAN, WAN, wireless LAN, internet, intranet, extranet. 6L

Network Models: Client/ server network and Peer-to-peer network, OSI, TCP/IP, layers and functionalities. 8L

Transmission Media: Introduction, Guided Media: Twisted pair, Coaxial cable, Optical fiber. Unguided media: Microwave, Radio frequency propagation, Satellite 4L

LAN Topologies : Ring, Bus, Star , Mesh and tree topologies **2L**

Network Devices: NIC, repeaters, hub, bridge, switch, gateway and router 2L

Internet Terms: Web page, Home page, website, internet browsers, URL, Hypertext, ISP, Web server, download and upload, online and offline. 2L

Internet Applications: www, telnet, ftp, e-mail, social networks, search engines, Video Conferencing, e-Commerce, m-Commerce, VOIP, blogs. 6L

Introduction to Web Design: Introduction to hypertext markup language (html) Document type definition, creating web pages, lists, hyperlinks, tables, web forms, inserting images, frames, hosting options and domain name registration. Customized Features: Cascading style sheet (css) for text formatting and other manipulations. 16L

JavaScript Fundamentals: Data types and variables, functions, methods and events, controlling program flow, JavaScript object model, built-in objects and operators. 14L

Course Outcomes

1. To understand the terminology, concepts of the OSI reference model and the TCP-IP reference model and protocols, design issues in local area networks and wide area networks
2. To be familiar with protocols and issues at physical and data link layer including various IEEE standards.
3. To have a good understanding of the IP Addressing ,network applications and network devices
4. To create web pages using HTML and JavaScript.

Reference Books:

1. Computer networks – Tannenbaum
2. Data Communication and Networking – Forouzan – Tata McGraw Hill.
3. D.R. Brooks, An Introduction to HTML and Javascript for Scientists and Engineers, Springer W. Willard, 4.HTML A Beginner's Guide, Tata McGraw-Hill Education, 2009.
4. J. A. Ramalho, Learn Advanced HTML 4.0 with DHTML, BPB Publications, 2007

Semester-III
Paper: Computer Networks and Internet Technologies Lab
Paper code: OCSC-302

Credits: 02		**SESSIONAL:**	**15**
L	P	THEORY EXAM:	35
0	4	TOTAL:	50

Practical: 60 lectures

Practical exercises based on concepts listed in theory using HTML.

1. Create HTML document with following formatting – Bold, Italics, Underline, Colors, Headings, Title, Font and Font Width, Background, Paragraph, Line Brakes, Horizontal Line, Blinking text as well as marquee text.

2. Create HTML document with Ordered and Unordered lists, Inserting Images, Internal and External linking

3. Create HTML document with Table:

<table>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="3"></td><td colspan="2" rowspan="3">Some image here</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td colspan="3"></td></tr>
</table>

4. Create Form with Input Type, Select and Text Area in HTML.

5. Create an HTML containing Roll No., student's name and Grades in a tabular form.

6. Create an HTML document (having two frames) which will appear as follows:

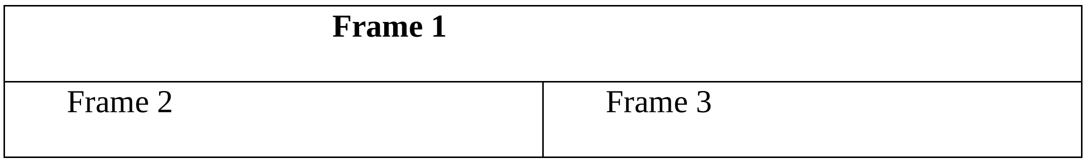
About Department 1 Department 2 Department 3	This frame would show the contents according to the link clicked by the user on the left frame

7. Create an HTML document containing horizontal frames as follows:

Department Names (could be along with Logos)
Contents according to the Link clicked

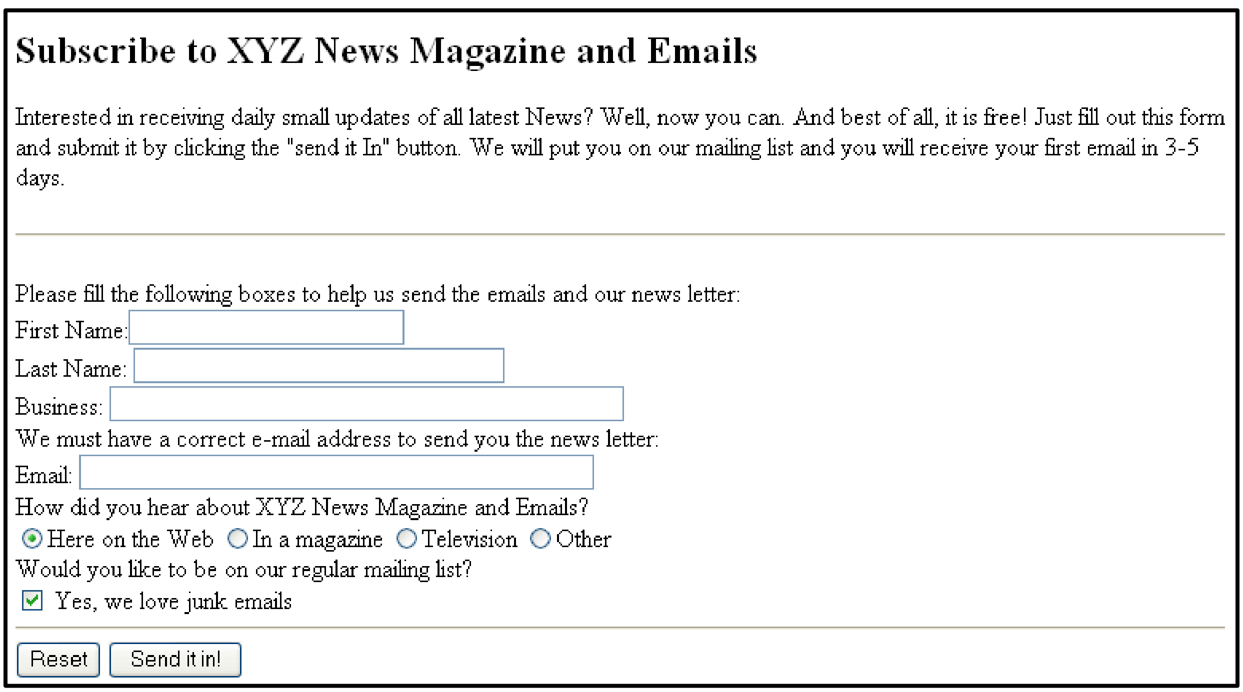
8. Create a website of 6 – 7 pages with different effects as mentioned in above problems.

9. Create HTML documents (having multiple frames) in the following formats



10. Create a form using HTML which has the following types of controls:

I. Text Box
II. Option/radio buttons
III. Check boxes
IV. IV. Reset and Submit buttons



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Would you like to be on our regular mailing list?
Yes, we love junk emails

Reset Send it in!

List of Practicals using Javascript :

Create event driven program for following:

1. Print a table of numbers from 5 to 15 and their squares and cubes using alert.

2. Print the largest of three numbers.
3. Find the factorial of a number n.
4. Enter a list of positive numbers terminated by Zero. Find the sum and average of these numbers.
5. A person deposits Rs 1000 in a fixed account yielding 5% interest. Compute the amount in theaccount at the end of each year for n years.
6. Read n numbers. Count the number of negative numbers, positive numbers and zeros in the list

Semester-III
Open Elective Mathematics
Paper: DIFFERENTIAL EQUATIONS
Paper Code: OMTH-301

Credits: 06

		SESSIONAL:	25
L	T	THEORY EXAM:	75
5	1	TOTAL:	100

Theory: 75 Lectures

COURSE OBJECTIVE

The course is designed to develop in students:

Appreciation for ODE and system of ODEs concepts that are encountered in the real world, understand and be able to communicate the underlying mathematics involved to help another person gain insight into the situation, work with Differential Equations and use correct mathematical terminology, notation, and symbolic processes in order to engage in work, study, and conversation on topics involving Differential equations. The students will learn to solve exact differential equations, linear differential equations and series solution of differential equations.

UNIT-I

First order ordinary differential equations: Basic concepts and ideas, Exact differential equations, Integrating factors, Bernoulli equations, Orthogonal trajectories of curves, Existence and uniqueness of solutions, Second order differential equations: Homogenous linear equations of second order, Second order homogenous equations with constant coefficients, Differential operator, Euler-Cauchy equation.

UNIT-II

Existence and uniqueness theory, Wronskian , Nonhomogenous ordinary differential equations, Solution by undetermined coefficients, Solution by variation of parameters, Higher order homogenous equations with constant coefficients, System of differential equations, System of differential equations, Conversion of n th order ODEs to a system, Basic concepts and ideas, Homogenous system with constant coefficients.

UNIT-III

Power series method: Theory of power series methods, Solution of differential equations by power series method, Legendre's equation, Legendre polynomial

UNIT IV

Partial differential equations: Basic Concepts and definitions, Mathematical problems, First order equations: Classification, Construction, Geometrical interpretation, Method of characteristics, General solutions of first order partial differential equations, Canonical forms and method of separation of variables for first order partial differential equations, Classification of second order partial differential equations, Reduction to canonical forms, Second order partial differential equations with constant coefficients, General solutions.

COURSE OUTCOMES:

Upon completion of course, students will be able to:

- Solve exact differential equations and linear differential equations.
- Solve differential equations by method of variation of parameters.
- Solve homogeneous and non- homogeneous differential equations.
- Solve partial differential equations.

REFERENCES:

- Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, Inc., 9/e, (2006)
- Tyn Myint–U and Lokenath Debnath; Linear Partial Differential Equations for Scientists and Engineers, Springer, Indian Reprint (2009)
- C.H. Edwards and D.E. Penny, Differential Equations and Boundary Value problems Computing and Modeling, Pearson Education India, 2005.
- S.L. Ross, *Differential Equations*, 3rd Ed., John Wiley and Sons, India, 2004.

Semester-III
Open Elective Electronics
Paper: Communication Systems
Paper Code: OELC-301

Credits: 04

L	T		
		SESSIONAL:	25
L	T	THEORY EXAM:	75
4	0	TOTAL:	100

Theory: 60 lecture

Unit-1 (16 Lectures)

Noise and Transmission lines: Noise-Introduction, internal and external noises, signal to noise ratio and noise figure

Amplitude Modulation/demodulation techniques: Block diagram of electronic communication system. Modulation-need and types of modulation-AM, FM & PM. Amplitude modulation – representation, modulation index, expression for instantaneous voltage, power relations, frequency spectrum, DSBFC, DSBSC and SSBSC (mention only). Limitations of AM.
Demodulation- AM detection: principles of detection, linear diode, principle of working and waveforms.
Block diagram of AM transmitter and Receiver.

Unit-2 (12 Lectures)

Frequency Modulation/demodulation techniques: Frequency Modulation: definition, modulation index, FM frequency spectrum diagram, bandwidth requirements, frequency deviation and carrier swing, FM generator-varactor diode modulator.
FM detector – principle, slope detector-circuit, principle of working and waveforms. Block diagram of FM transmitter and Receiver. Comparison of AM and FM.

Unit- 3(16 Lectures)

Digital communication: Introduction to pulse and digital communications, digital radio, sampling theorem, types- PAM, PWM, PPM, PCM – quantization, advantages and applications, digital modulations (FSK, PSK, and ASK). Advantage and disadvantages of digital transmission, characteristics of data transmission circuits – Shannon limit for information capacity, bandwidth requirements, data transmission speed, noise, cross talk, echo suppressors, distortion and equalizer, MODEM– modes, classification, interfacing (RS232). TDMA, FDMA, CDMA concepts, comparison of TDMA and FDMA

Unit- 4(16 Lectures)

Cellular Communication: Concept of cellular mobile communication – cell and cell splitting, frequency bands used in cellular communication, absolute RF channel numbers (ARFCN), frequency reuse, roaming and hand off, authentication of the SIM card of the subscribers, IMEI number, concept of data encryption, architecture (block diagram) of cellular mobile communication network, CDMA technology, CDMA overview, simplified block diagram of cellular phone handset, Comparative study of GSM and CDMA, 2G, 3G and 4G concepts.
Satellite communication: Introduction, to Orbit, types of orbits, Block diagram of satellite transponder.

Course Outcomes: After the completion of the course, students will be able to,

- Know amplitude modulation an demodulation techniques in detail
- Understand frequency modulation an demodulation techniques in detail
- Learn various digital communication techniques.
- Have an understanding of cellular communication and satellite communication.

Suggested Books:

1. Electronic Communication, George Kennedy, 3rd edition, TMH.
2. Electronic Communication, Roddy and Coolen, 4th edition, PHI.
3. Electronic Communication systems, Kennedy & Davis, IV edition-TATA McGraw Hill.
4. Advanced Electronic Communication systems, Wayne Tomasi- 6th edition, Low priced edition- Pearson education

Semester-III

Paper: Communication Systems Lab

Paper code: OELC-302

Credits: 02		**SESSIONAL:**	**15**
L	P	THEORY EXAM:	35
0	4	TOTAL:	50

Practical: 60 lectures

1. Amplitude modulator and Amplitude demodulator
2. Study of FM modulator using IC8038
3. Study of VCO using IC 566
4. Study of Time Division Multiplexing and de multiplexing
5. Study of AM Transmitter/Receiver
6. Study of FM Transmitter/Receiver
7. ASK modulator and demodulator
8. Study of FSK modulation
9. Study of PWM and PPM
10. Study of PAM modulator and demodulator

Semester-III
Open Elective Chemistry
Paper: Organic Chemistry
Paper Code: OCHE-301

Credits: 04

L	T		
		SESSIONAL:	25
L	T	THEORY EXAM:	75
4	0	TOTAL:	100

Course Objectives: To learn and understand the basic concepts Organic chemistry.

Unit I
Fundamental of organic chemistry
Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis.
Reaction intermediates: Carbocations, Carbanions and free radicals. Electrophiles and nucleophiles
Aromaticity: Benzenoids and Hückel's rule.

Stereochemistry

Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L; *cis - trans* nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems).

Unit II
Aliphatic Hydrocarbons

Functional group approach for the following reactions (preparations physical property & chemical reactions) to be studied with mechanism in context to their structure.

Alkanes: *Preparation:* Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, Grignard reagent. *Reactions:* Free radical Substitution: Halogenation.

Alkenes: *Preparation:* Elimination reactions: Dehydration of alcohols and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). *Reactions:* cis-addition (alk. $KMnO_4$) andtrans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymecuration-demercuration, Hydroboration-oxidation.

Alkynes: *Preparation:* Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides. *Reactions:* formation of metal acetylides and acidity of alkynes, addition of bromine and alkaline $KMnO_4$, ozonolysis and oxidation with hot alk. $KMnO_4$. Hydration to form carbonyl compounds
Unit III

Aromatic hydrocarbons

Preparation (benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid.
Reactions: (benzene): Electrophilic substitution reactions: nitration, halogenation sulphonation. Friedel-Craft's reaction (alkylation and acylation) Side chain oxidation of alkyl benzenes.

Alkyl Halides .
Preparation: from alkenes *and* alcohols.

Reactions: Types of Nucleophilic Substitution (SN1, SN2 and SNi) reactions, hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson's ether synthesis: Elimination vs substitution.
Aryl Halides *Preparation:* (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer & Gattermann reactions.
Reactions (Chlorobenzene): Aromatic electrophilic and nucleophilic substitution (replacement by –OHgroup) and effect of nitro substituent. Benzyne Mechanism: KNH2/NH3 (or NaNH2/NH3).
Relative reactivity of alkyl, allyl, benzyl, vinyl and aryl halides towards Nucleophilic substitution reactions. .
Unit IV

Alcohols: *Preparation:* Preparation of 1o, 2o and 3o alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters.
Reactions: With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk. KMnO4, acidic dichromate, conc. HNO3), factors affecting acidity, Oppeneauer oxidation
Diols: oxidation of diols. Pinacol-Pinacolone rearrangement.
Phenols: (Phenol case) *Preparation:* Cumene hydroperoxide method, from diazonium salts. *Reactions:* Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer-Tiemann Reaction, Gattermann-Koch Reaction, Houben–Hoesch Condensation, Schotten – Baumann Reaction. acidity and factors affecting
Ethers (aliphatic and aromatic). Preparation : Williamson ether synthesis. **Reactions:** Cleavage of ethers with HI
Aldehydes and ketones (aliphatic and aromatic):
Preparation: from acid chlorides and from nitriles.

Reactions – Nucleophilic addition, Nucleophilic addition – elimination reaction including Reaction with HCN, ROH, NaHSO3, NH2-G derivatives. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemensen reduction and Wolff Kishner reduction. Meerwein-Pondorff Verley reduction.
Course Outcomes:
After the successful completion of the course the learner would be able to

i. Understand the basic concept of organic chemistry.
ii. Understand stereochemistry of organic compunds
iii. Understand mechanisms of organic reactions.

iv. Understand the methods of preparation and reaction of different functional groups in organic chemistry.

Reference Books:

- T. W. Graham Solomons: *Organic Chemistry, John Wiley and Sons*.
- Peter Sykes: *A Guide Book to Mechanism in Organic Chemistry*, Orient Longman.
- I.L. Finar: *Organic Chemistry* (Vol. I & II), E. L. B. S.
- R. T. Morrison & R. N. Boyd: *Organic Chemistry*, Prentice Hall.
- Arun Bahl and B. S. Bahl: *Advanced Organic Chemistry,* S. Chand.

Syllabus of B.Sc. (H) Physics

Semester IV

Discipline Core Course (DCC)

B.Sc.(H) Physics Sem-IV
Paper: Mathematical Physics-III
Paper Code: BPH-401

No. of Credits: 4	**Sessional: 25**
L: 4, T: 0	**Theory Exam: 75**
Theory: 60 Lectures	**Total: 100**

Course Objectives: *The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.*

Complex Analysis: Brief Revision of Complex Numbers and their Graphical Representation. Euler's formula, De Moivre's theorem, Roots of Complex Numbers. Functions of Complex Variables. Analyticity and Cauchy-Riemann Conditions. Examples of analytic functions. Singular functions: poles and branch points, order of singularity, branch cuts. (15 Lectures)

Integration of a function of a complex variable: Cauchy's Inequality. Cauchy's Integral formula. Simply and multiply connected region. Laurent and Taylor's expansion. Residues and Residue Theorem. Application in solving Definite Integrals. (15 Lectures)

Integrals Transforms: Fourier Transforms: Fourier Integral theorem. Fourier Transform. Examples. Fourier transform of trigonometric, Gaussian, finite wave train and other functions. Representation of Dirac delta function as a Fourier Integral. Fourier transform of derivatives, Inverse Fourier transform, Convolution theorem. Properties of Fourier transforms (translation, change of scale, complex conjugation, etc.). One dimensional Wave Equations, Dirac delta function, definition and properties. (15 Lectures)

Laplace Transforms: Laplace Transform (LT) of Elementary functions. Properties of LTs: Change of Scale Theorem, Shifting Theorem. LTs of 1^{st} and 2^{nd} order Derivatives and Integrals of Functions, Derivatives and Integrals of LTs. LT of Unit Step function, Dirac Delta function, Periodic Functions. Convolution Theorem. Inverse LT. Application of Laplace Transforms to 2^{nd} order Differential Equations: Coupled differential equations of 1^{st} order. Solution of heat flow along semi infinite bar using Laplace transform. (15 Lectures)

Course Outcomes: After the completion of the course, students will be able to,

- Know the concepts of complex numbers, function of complex variables and their singularities.
- Integrate the functions of complex variables
- Learn the Fourier transform techniques of various functions and associated theorems.
- Learn the Laplace transform techniques of various functions and associated theorems.

Reference Books:

Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press

Mathematics for Physicists, P.Dennery and A.Krzywicki, 1967, Dover Publications

Complex Variables, A.S.Fokas & M.J.Ablowitz, 8th Ed., 2011, Cambridge Univ. Press Complex Variables, A.K. Kapoor, 2014, Cambridge Univ. Press

Complex Variables and Applications, J.W.Brown & R.V.Churchill, 7th Ed. 2003, Tata McGraw-Hill

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B.Sc.(H) Physics Sem-IV
Paper: Mathematical Physics-III Lab
Paper Code: BPH-404

No. of Credits: 2	**Sessional: 15**
L: 0, P: 4	**External Exam: 35**
Lab: 60 Periods	**Total: 50**

C^{++}/Scilab based simulations experiments on Mathematical Physics problems like

1. Solve differential equations:

$dy/dx = e^{-x}$ with $y = 0$ for $x = 0$

$dy/dx + e^{-x}y = x^2$

$d^2y/dt^2 + 2\, dy/dt = -y$

$d^2y/dt^2 + e^{-t}dy/dt = -y$

2. Dirac Delta Function:

$$\text{Evaluate } \frac{1}{\sqrt{2\pi\sigma^2}}\int e^{\frac{-(x-2)^2}{2\sigma^2}}(x+3)\,dx,$$ *for = 1, 0.1, 0.01 and show it tends to 5*

3. Fourier Series:

(i) Program to sum $\sum_{n=1}^{\infty}(0.2)^n$

(ii) Evaluate the Fourier coefficient of a given periodic function (square wave)

4. Frobenius method and special functions:

(i) $\int_{-1}^{+1} P_n(x).P_m(x)\, dx = \delta_{n,m}$

(ii) Plot $P_n(x)$ and $J_n(x)$

Show recursion relation

5. Calculation of error for each data point of observations recorded in experiments done in previous semesters (choose any two).

6. Calculation of least square fitting manually without giving weightage to error. Confirmation of least square fitting of data through computer program.

7. Evaluation of trigonometric functions e.g. *sin θ,* Given Bessel's function at N points find its value at an intermediate point. Complex analysis: Integrate $1/(x^2+2)$ numerically and check with computer integration.

8. Integral transform: FFT of e^{-x^2}

Reference Books:

- Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández. 2014 Springer ISBN: 978-3319067896
- A Guide to MATLAB, B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, 2014, 3rd Edn., Cambridge University Press
- Getting started with Matlab, Rudra Pratap, 2010, Oxford University Press.

B.Sc.(H) Physics Sem-IV
Paper: ELEMENTS OF MODERN PHYSICS
Paper Code: BPH-402

No. of Credits: 4	**Sessional: 25**
L: 4, T: 0	**Theory Exam: 75**
Theory: 60 Lectures	**Total: 100**

COURSE OBJECTIVE

The objective of the course is to get the students aware how the development in Modern Physics changed the Physics throughout.

Planck's quantum, Planck's constant and light as a collection of photons; Blackbody Radiation: Quantum theory of Light; Photo-electric effect and Compton scattering. De Broglie wavelength and matter waves; Davisson-Germer experiment. Wave description of particles by wave packets. Group and Phase velocities and relation between them. Two-Slit experiment with electrons. Probability. Wave amplitude and wave functions. (15 Lectures)

Position measurement- gamma ray microscope thought experiment; Wave-particle duality, Heisenberg uncertainty principle (Uncertainty relations involving Canonical pair of variables): Estimating minimum energy of a confined particle using uncertainty principle. (4 Lectures)

Two slit interference experiment with photons, atoms and particles; linear superposition principle as a consequence; Matter waves and wave amplitude; Schrodinger equation for non-relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of a wave function, probabilities and normalization; Probability and probability current densities in one dimension. (10 Lectures)

One dimensional infinitely rigid box- energy eigen values and eigen functions, normalization; Quantum dot as example; Quantum mechanical scattering and tunnelling in one dimension-across a step potential & rectangular potential barrier. (10 Lectures)

Size and structure of atomic nucleus and its relation with atomic weight; Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle. Nature of nuclear force, NZ graph, Liquid Drop model: semi-empirical mass formula and binding energy. (7 Lectures)

Radioactivity: stability of the nucleus; Law of radioactive decay; Mean life and half-life; Alpha decay; Beta decay- energy released, spectrum and Pauli's prediction of neutrino; Gamma ray emission, energy-momentum conservation: electron-positron pair creation by gamma photons in the vicinity of a nucleus. (9 Lectures)

Lasers: Metastable states. Spontaneous and Stimulated emissions. Einstein Coefficients, Optical Pumping and Population Inversion. Basic lasing. (5 Lectures)

Course Outcomes: After the completion of the course, students will be able to,

- Know the basic concepts od old Quantum theory
- Understand the interference and basics of the wave theory
- Learn the basic properties of nucleus and nuclear binding energy.
- Have an understanding of Nuclear radioactivity laws and basics of Lasers.

Reference Books:

- Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
- Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGraw Hill
- Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.
- Modern Physics, G.Kaur and G.R. Pickrell, 2014, McGraw Hill

B.Sc.(H) Physics Sem-IV
Paper: Modern Physics Lab
Paper Code: BPH-405

No. of Credits: 2 **Sessional: 15**
L: 0, P: 4 **External Exam: 35**
Lab: 60 Periods **Total: 50**

At least 06 experiments from following:

1. Measurement of Planck's constant using black body radiation and photo-detector.
2. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light
3. To determine work function of material of filament of directly heated vacuum diode.
4. To determine the Planck's constant using LEDs of at least 4 different colours.
5. To determine the wavelength of H-alpha emission line of Hydrogen atom.
6. To determine the ionization potential of mercury.
7. To determine the absorption lines in the rotational spectrum of Iodine vapour.
8. To determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet.
9. To setup the Millikan oil drop apparatus and determine the charge of an electron.
10. To show the tunneling effect in tunnel diode using I-V characteristics.
11. To determine the wavelength of laser source using diffraction of single slit.
12. To determine the wavelength of laser source using diffraction of double slits.
13. To determine angular spread of He-Ne laser using plane diffraction grating

Reference Books

- Advanced Practical Physics for students, B.L. Flint and H.T.Worsnop, 1971, Asia Publishing House
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Edn, 2011,Kitab Mahal

B.Sc.(H) Physics Sem-IV
Paper: DIGITAL SYSTEMS AND APPLICATIONS
Paper Code: BPH-403

No. of Credits: 4 **Sessional: 25**
L: 4, T: 0 **Theory Exam: 75**
Theory: 60 Lectures **Total: 100**

COURSE OBJECTIVE
The objective of the course is to get knowledge of the digital systems and their applications in technology.

Digital Circuits: Difference between Analog and Digital Circuits. Binary Numbers. Decimal to Binary and Binary to Decimal Conversion. BCD, Octal and Hexadecimal numbers. AND, OR and NOT Gates (realization using Diodes and Transistor). NAND and NOR Gates as Universal Gates. XOR and XNOR Gates and application as Parity Checkers. (6 Lectures)

Boolean algebra: De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Algebra. Idea of Minterms and Maxterms. Conversion of Truth table into Equivalent Logic Circuit by (1) Sum of Products (SOP), Product of Sum (POS) Method and (2) Karnaugh Map. (8 Lectures)

Data processing circuits: Multiplexers, De-multiplexers, Decoders, Encoders. (4 Lectures)

Arithmetic Circuits: Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders. Half & Full Subtractors, 4-bit binary Adder/Subtractor. (4 Lectures)

Sequential Circuits: SR, D, T and JK Flip-Flops. Clocked (Level and Edge Triggered) Flip-Flops. Preset and Clear operations. Race-around conditions in JK Flip-Flop. M/S JK Flip-Flop. (6 Lectures)

Shift registers: Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel-in-Parallel-out Shift Registers (only up to 4 bits). (4 Lectures)

Counters(4 bits): Ring Counter. Asynchronous counters, Decade Counter. Synchronous Counter. (4 Lectures)

Timers: IC 555: block diagram and applications: Astable multivibrator and Monostable multivibrator. (4 Lectures)

Integrated Circuits (Qualitative treatment only): Active and Passive components. Discrete components. Wafer. Chip. Advantages and drawbacks of ICs. Scale of integration: SSI, MSI, LSI and VLSI (basic idea and definitions only). Classification of ICs. Examples of Linear and Digital lCs. (3 Lectures)

Memory Organization: Data storage (idea of RAM and ROM). Computer memory. Memory organization and addressing. Memory Map. (3 Lectures)

Intel 8085 Microprocessor Architecture: Main features of 8085. Block diagram. Components. Pin-out diagram. Buses. Registers. ALU. Memory. Stack memory. Timing and Control circuitry. Timing states. Instruction cycle, Timing diagram of MOV and MVI. (10 Lectures)

Introduction to Assembly Language:1 byte, 2 byte and 3 byte instructions. (4 Lectures)

Course Outcomes: After the completion of the course, students will be able to,

- Know the basic digital circuits and Boolean algebra.
- Understand the circuitry, working and applications of data processing circuits and arithmetic circuits.
- Learn the working and applications of sequential circuits shift registers, counters and their applications.
- Have a basic knowledge of ICs, Timer ICs and Memory ICs.
- Learn the basics of microprocessor and assembly Language.

Reference Books:

- Digital Principles and Applications, A.P.Malvino, D.P. Leach and Saha, 7th Ed., 2011, Tata McGraw
- Fundamentals of Digital Circuits, Anand Kumar, 2nd Edn, 2009, PHI Learning Pvt. Ltd.
- Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
- Digital Electronics G K Kharate ,2010, Oxford University Press Logic circuit design, Shimon P. Vingron, 2012, Springer.
- Microprocessor Architecture Programming & applications with 8085, 2002, R.S. Goankar, Prentice Hall.

B.Sc.(H) Physics Sem-IV
Paper: Digital Systems & Applications Lab
Paper Code: BPH-406

No. of Credits: 2	**Sessional: 15**
L: 0, P: 4	**External Exam: 35**
Lab: 60 Periods	**Total: 50**

At least 06 experiments each from section A and Section B Section-A: Digital Circuits Hardware design/Verilog Design

1. To design a combinational logic system for a specified Truth Table.
   (b) To convert Boolean expression into logic circuit & design it using logic gate ICs.
   (c) To minimize a given logic circuit.
2. Half Adder, Full Adder and 4-bit binary Adder.

3. Half Subtractor, Full Subtractor, Adder-Subtractor using Full Adder I.C.
4. To build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates.
5. To build JK Master-slave flip-flop using Flip-Flop ICs
6. To build a 4-bit Counter using D-type/JK Flip-Flop ICs and study timing diagram.
7. To make a 4-bit Shift Register (serial and parallel) using D-type/JK Flip-Flop ICs.
8. To design an astable multivibrator of given specifications using 555 Timer.
9. To design a monostable multivibrator of given specifications using 555 Timer.

Section-B: Programs using 8085 Microprocessor:

1. Addition and subtraction of numbers using direct addressing mode
2. Addition and subtraction of numbers using indirect addressing mode
3. Multiplication by repeated addition.
4. Division by repeated subtraction.
5. Handling of 16-bit Numbers.
6. Use of CALL and RETURN Instruction.
7. Block data handling.
8. Other programs (e.g. Parity Check, using interrupts, etc.).

Reference Books:

Modern Digital Electronics, R.P. Jain, 4th Edition, 2010, Tata McGraw Hill.
Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.
Microprocessor Architecture Programming and applications with 8085, R.S. Goankar, 2002, Prentice Hall.
Microprocessor 8085:Architecture, Programming and interfacing, A.Wadhwa, 2010, PHI Learning.

Open Elective Courses (OEC)

Semester-IV

Open Elective Chemistry

Paper: Spectroscopy

Paper Code: OCHE-401

Credits: 04

		SESSIONAL:	25
L	T	THEORY EXAM:	75
4	0	TOTAL:	100

Course Objectives: To learn and understand the basic concepts of spectroscopy.

Unit I

Spectroscopy;

Introduction, Electromagnetic radiation, regions of spectrum, basic features of spectroscopy, statement of Born-oppenheimer approximation, Degrees of freedom.

Rotational Spectrum

Selection rules, Energy levels of rigid rotator (semi-classical principles), rotational spectra of diatomic molecules , spectral intensity distribution using population distribution (Maxwell-Boltzmann distribution), determination of bond length and isotopic effect .

Unit II

Ultraviolet (UV) absorption spectroscopy

Absorption laws (Beer-Lambert law), molar absorptivity, presentation and analysis of UV spectra, types of electronic transitions, effect of conjugation. Concept of chromophore and auxochrome. Bathochromic, hypsochromic, hyperchromic and hypochromic shifts. UV spectra of conjugated enes and enones,Woodward- Fieser rules, calculation of λm a x of simple conjugated dienes and α,β -unsaturated ketones. Applications of UV Spectroscopy in structure elucidation of simpl e

Unit III

Vibrational spectrum

Infrared (IR) absorption spectroscopy Molecular vibrations, Hooke's law, selection rules, intensity and position of IR bands, measurement of IR spectrum, fingerprint region, characteristic absorptions of various functional groups and interpretation of IR spectra of simple organic compounds. Applications of IR spectroscopy in structure elucidation of simple organic compounds

Raman Spectrum

Concept of polarizibility, pure rotational and pure vibrational Raman spectra of diatomic molecules, selection rules, Quantum theory of Raman spectra.

Unit IV

NMR Spectroscopy

Principle of nuclear magnetic resonance, the PMR spectrum,number of signals, peak areas, equivalent and nonequivalent protons positions of signals and chemical shift,shielding and deshielding of protons, proton counting,splitting of signals and coupling constants, magnetic equivalence of protons.Discussion of PMR spectra of the molecules: ethyl bromide, n-propyl bromide, isopropyl bromide, 1,1-dibromoethane, ethanol, acetaldehyde, ethyl acetate, toluene, benzaldehyde and acetophenone.

Simple problems on PMR spectroscopy for structure determination of organic compounds.

Course Outcomes:

After the successful completion of the course the learner would be able to

i. Understand the basic concept of spectroscopy and rotational spectroscopy.
ii. Understand the concept of UV-Visible spectroscopy
iii. Understand the concept of IR spectroscopy
iv. Understand the concept of NMR spectroscopy and structure elucidation problems using spectral data.

Understand the role of inorganic chemistry in biological systems

Books Suggested

1. Introduction to Spectroscopy- A Guide for Students of Organic Chemistry, 2nd Edn. By Donald L. Pavia, Gary M. Lampman and George S. Kriz. Saunders Golden Sunburst Series. Harcourt Brace College Publishers, New York.
2. Spectrometric Identification of Organic Compounds, R. M. Silverstein, G. C. Bassler and T. C. Morrill, John Wiley.
3. Application of Spectroscopy of Organic Compounds, J. R. Dyer, Prentice Hall.
4. Spectroscopic Methods in Organic Chemistry, D. H. Williams and I. Fleming, Tata McGraw-Hill.
5. Spectroscopy of Organic Compounds by P.S. Kalsi, Wiley Estern, New Delhi.
6. Organic Spectgroscopy by William Kemp, John Wiley.
7. Organic Mass Spectrometry by K.G. Das & E.P. James, Oxford & IBH Publishing Co.
8. Organic Spectroscopy (Principles & Applications) by Jagmohan.

Semester-IV
Open Elective Electronics
Paper: Microprocessor and Microcontroller System
Paper Code: OELC 401

Credits: 04

		SESSIONAL:	25
L	T	THEORY EXAM:	75
4	0	TOTAL:	100

Total Lectures 60

Unit-1 (15 Lectures)

Number systems: Binary, hexadecimal – conversion from binary to decimal and vice-versa, binary to hexadecimal and vice-versa, decimal to hexadecimal and vice versa, addition and subtraction of binary numbers and hexadecimal numbers. Subtraction using 2's complement, signed number arithmetic.

Introduction to Microprocessor: Introduction, applications, basic block diagram, speed, word size, memory capacity, classification of microprocessors (mention different microprocessors being used)

Microprocessor 8085: Features, architecture -block diagram, internal registers, register pairs, flags, stack pointer, program counter, types of buses. Multiplexed address and data bus, generation of control signals, pin description of microprocessor 8085.

Unit-2 (15 Lectures)
8085 Instructions: Operation code, Operand & Mnemonics.
Instruction set of 8085, instruction classification, addressing modes, instruction format.
Data transfer instructions, arithmetic instructions, increment & decrement instructions, logical instructions, branch instructions and machine control instructions.
Stack operations, subroutine calls and return operations. Delay loops, use of counters, timing diagrams-instruction cycle, machine cycle, T- states, time delay

Unit-3 (13 Lectures)
Interrupt structure of 8085A microprocessor, processing of vectored and non-vectored interrupts, latency time and response time
Interfacing of memory chips, address allocation technique and decoding; Interfacing of I/O devices, LEDs and toggle-switches as examples, memory mapped and isolated I/O structure; Input/output techniques: CPU initiated unconditional and conditional I/O transfer.

Unit- 4 (17 Lectures)
Introduction to Microcontrollers: Basic block diagram, comparison of microcontroller with microprocessors, comparison of 8 bit, 16 bit and 32 bit microcontrollers.
MICROCONTROLLER 8051- architecture **-**internal block diagram, key features of 8051, pin diagram, memory organization, Internal RAM memory, Internal ROM. General purpose data memory, special purpose/function registers, external memory.
Counters and timers: 8051 oscillator and clock, program counter, TCON, TMOD, timer counter interrupts, timer modes of operation. Input / output ports and circuits/ configurations, serial data input / output – SCON, PCON, serial data transmission modes.

Course Outcomes: After the completion of the course, students will be able to,

- Know the number system and basics of microprocessor 8085
- Learn the basic programming instructions of 8085 μ-P.
- Learn the interfacing of various I/O devices.
- Have a basic knowledge of Microcontroller, counters and timers.

Suggested Books:

1. Microprocessor Architecture, Programming and Applications with 8085, Ramesh S.Gaonkar - Wiley Eastern Limited- IV Edition.
2. Fundamentals of Microprocessor & Microcomputer: B. Ram— Danpat Rai Publications.
3. Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D. MCKinlay ―The 8051 Microcontroller and Embedded Systems‖, 2nd Edition, Pearson Education 2008.

Semester-IV

Paper: Microprocessor and Microcontroller System Lab

Paper code: OELC-402

Credits: 02	**SESSIONAL: 15**
L P	THEORY EXAM: 35
0 4	TOTAL: 50

Practical: 60 lectures

1. Program to transfer a block of data.
2. Program for multibyte addition
3. Program for multibyte subtraction
4. Program to multiply two 8-bit numbers.
5. Program to divide a 16 bit number by 8 bit number.
6. Program to search a given number in a given list.
7. Program to generate terms of Fibonacci series.
8. Program to sort numbers in ascending/descending order.
9. Program to find the square root of an integer.
10. To study interfacing of IC 8255.
11. Program to verify the truth table of logic gates.

Semester-IV
Open Elective Mathematics
Paper: NUMERICAL METHODS
Paper Code: OMTH-401

Credits: 06

	SESSIONAL: 25
L T	THEORY EXAM: 75
5 1	TOTAL: 100

Theory: 75 lecture

COURSE OBJECTIVES

The main objective of this course is to give the solutions of applied problems and it helps students to have an in-depth knowledge of various advanced methods in numerical analysis.

UNIT-I

Floating point representation and computer arithmetic, Significant digits, Errors: Roundoff error, Local truncation error, Global truncation error, Order of a method, Convergence and terminal conditions, Solution of algebraic and transcendental equations: Bisection method, method of false position,secant method, iteration method, Newton's Raphson method, Generalised Newton-Raphson method.

UNIT-II

Various difference operators and relation between them .Newton‘s forward and backward interpolation formulae. Central difference interpolation formula. Gauss forward and backward interpolation formulae. Langrange’s interpolation formula and Newton‘s divided difference formulae.

UNIT-III

Solution of simultaneous algebraic equations: Jacobi's method, Gauss-Seidal method, Relaxation method.

Numerical differentiation and integration: Formula for derivatives, Trapezoidal rule, Simpson's 1/3rd and 3/8th rules, Boole's rule and Weddle's rule, Romberg's Integration.

UNIT-IV

Numerical solution of O.D.E.: Taylor series, Picard‘s method, Euler’s Method, Modified Euler method, Runge-Kutta second and fourth order methods, predictor collector methods(Adams-Bashforth and Milne's method only).

COURSE OUTCOMES

After completing this course satisfactorily, a student will be able to:

- Understand about the solution of algebraic equations, transcendental equations and simultaneous algebraic equations.
- Understand about Newton‘s forward and backward interpolation formulae, Central difference interpolation formula, Gauss forward and backward interpolation formulae, Langranges interpolation formula and Newton‘s divided difference formulae.
- Understand about the solution of Trapezoidal rule, Simpson's 1/3rd and 3/8th rules, Boole's rule and Weddle's rule, Romberg's Integration
- Understand about the numerical solution of ODE and PDE

REFERENCES BOOKS

1. K. Atkinson and W. Han, Elementary Numerical Analysis, John Wiley,2006.
2. Numerical Methods in Engg. &Science : B.S. Grewal :khanna publications.
3. Numerical Methods for Scientific and Engg. Computations : M.K. Jain, S.R.K. Iyengerand R.K. Jain-Wiley Eastern Ltd
4. Taneja, H.C. "Advanced Engineering Mathematics", IK International, New Delhi.
5. Introductory Methods of Numerical Analysis: S.S. Shastri, PHI learning pvt limited.

Semester-IV
Open Elective Computer Science
Paper: Information Security
Paper Code: OCSC-401

Credits: 04

		SESSIONAL:	25
L	T	THEORY EXAM:	75
4	0	TOTAL:	100

Theory: 60 lecture

Course Objectives:

1. To study goals of security and ethical issues related to the misuse of computer security.
2. Understand the basic concept of Cryptography and Network Security, their mathematical models.
3. To understand various types of ciphers, DES, AES, message Authentication, digital Signature System.
4. To get knowledge about network security, virus, worms and firewall and Acquire knowledge in security issues, services, goals and mechanism
5. Understand the SSL or firewall based solution against security threats.

Course Introduction: Computer network as a threat, hardware vulnerability, software vulnerability, importance of data security.

Digital Crime: Overview of digital crime, criminology of computer crime.

Information Gathering Techniques: Tools of the attacker, information and cyber warfare, scanning and spoofing, password cracking, malicious software, session hijacking

Risk Analysis and Threat: Risk analysis, process, key principles of conventional computer security, security policies, authentication, data protection, access control, internal vs external threat, security assurance, passwords, authentication, and access control, computer forensics and incident response

Introduction to Cryptography and Applications : Important terms, Threat, Flaw, Vulnerability, Exploit, Attack, Ciphers, Codes, Caeser Cipher, Rail-Fence Cipher, Public key cryptography (Definitions only), Private key cryptography (Definition and Example), Digital Certificates

Safety Tools and Issues : Firewalls, logging and intrusion detection systems, Windows and windows XP / NT security, Unix/Linux security, ethics of hacking and cracking

Course Outcomes:

After the completion of this course the student will able to:

1. Understand theory of fundamental cryptography, encryption and decryption algorithms,
2. Build secure authentication systems by use of message authentication techniques.
3. Understand a given ciphering algorithm and to analyze it.

4. Apply the crypto systems so far learned to building of information and network security mechanisms.

Reference Books:

1. M. Merkow, J. Breithaupt, Information Security Principles and Practices, Pearson Education.2005
2. G.R.F. Snyder, T. Pardoe, Network Security, Cengage Learning, 2010
3. A. Basta, W.Halton, Computer Security: Concepts, Issues and Implementation, Cengage Learning India, 2008

Semester-IV

Paper: Information Security Lab

Paper code: OCSC-402

Credits: 02		**SESSIONAL:**	**15**
L	P	THEORY EXAM:	35
0	4	TOTAL:	50

Practical: 60 lectures

1. Demonstrate the use of Network tools: ping, ipconfig, ifconfig, tracert, arp, netstat, whois
2. Use of Password cracking tools : John the Ripper, Ophcrack. Verify the strength of passwords using these tools.
3. Perform encryption and decryption of Caesar cipher. Write a script for performing these operations.
4. Perform encryption and decryption of a Rail fence cipher. Write a script for performing these operations.
5. Use nmap/zenmap to analyse a remote machine.
6. Use Burp proxy to capture and modify the message.
7. Demonstrate sending of a protected word document.
8. Demonstrate sending of a digitally signed document.
9. Demonstrate sending of a protected worksheet.
10. Demonstrate use of steganography tools.
11. Demonstrate use of gpg utility for signing and encrypting purposes.

Skill Enhancement Course in Physics (SECP)

Common for Semester- III & IV

(Choose any one SEC course and respective lab in each semester (III & IV)

B.Sc.(H) Physics
Paper: Computational Physics Skills
Paper Code: SECP-01

No. of Credits: 2	**Sessional: 25**
L: 2, T: 0	**Theory Exam: 75**
Theory: 30 Lectures	**Total: 100**

Course Objective: *The aim of this course is not just to teach computer programming and numerical analysis but to emphasize its role in solving problems in Physics and Science. Highlights the use of computational methods to solve physical problems Use of computer language as a tool in solving physics/science problems*

Course will consist of hands on training on the Problem solving on Computers.

Introduction: Usage of linux as an Editor. Algorithms and Flowcharts: Algorithm: Definition, properties and development. Flowchart: Concept of flowchart, symbols, guidelines, types. Examples: Roots of Quadratic Equation, Sum of two matrices, Sum and Product of a finite series, calculation of sin(x) as a series. (4 Lectures)

Scientific Programming: Some fundamental Linux Commands (Internal and External commands). Development of FORTRAN, Basic elements of FORTRAN: Character Set, Constants and their types, Variables and their types, Keywords, Variable Declaration and concept of instruction and program. Operators: Arithmetic, Relational, Logical and Assignment Operators. Expressions: Arithmetic, Relational, Logical, Character and Assignment Expressions. Fortran Statements: I/O Statements (unformatted/formatted), Executable and Non-Executable Statements, Layout of Fortran Program, Format of writing Program and concept of coding, Initialization and Replacement Logic. Examples from physics problems. (8 Lectures)

Control Statements: Types of Logic (Sequential, Selection, Repetition), Branching Statements (Logical IF, Arithmetic IF, Block IF, Nested Block IF, SELECT CASE and ELSE IF Ladder statements), Looping Statements (DO-CONTINUE, DO-ENDDO, DO-WHILE, Implied and Nested DO Loops), Jumping Statements (Unconditional GOTO, Computed GOTO, Assigned GOTO) Subscripted Variables (Arrays: Types of Arrays, DIMENSION Statement, Reading and Writing Arrays), Functions and Subroutines (Arithmetic Statement Function, Function Subprogram and Subroutine), RETURN, CALL, COMMON and EQUIVALENCE Statements), Structure, Disk

I/O Statements, open a file, writing in a file, reading from a file. Examples from physics problems. (12 Lectures)

Visualization: Introduction to graphical analysis and its limitations. Introduction to Gnuplot. basic Gnuplot commands: simple plots, plotting data from a file, saving and exporting, physics with Gnuplot (equations, building functions, user defined variables and functions), Understanding data with Gnuplot (6 Lectures)

Course Outcomes: After the completion of the course, students will be able to,

- Know the basics of Linux, algorithm and flowcharts.
- Learn the FORTRAN programming language.
- Learn various controlling and looping statements in FORTRAN.
- Have a basic understanding of the physics of gnuplots.

Reference Books:

- Introduction to Numerical Analysis, S.S. Sastry, 5th Edn., 2012, PHI Learning Pvt. Ltd.
- Computer Programming in Fortran 77". V. Rajaraman (Publisher:PHI).
- Gnuplot in action: understanding data with graphs, Philip K Janert, (Manning 2010)
- Schaum's Outline of Theory and Problems of Programming with Fortran, S Lipsdutz and A Poe, 1986Mc-Graw Hill Book Co.
- Computational Physics: An Introduction, R. C. Verma, etal. New Age International Publishers, New Delhi(1999)
- Elementary Numerical Analysis, K.E.Atkinson,3 rd Edn . , 2 007 , Wiley India Edition.

B.Sc.(H) Physics
Paper: Computational Physics Skills Lab
Paper Code: SECP-04

No. of Credits: 0	**Sessional: 15**
L: 0, P: 2	**Theory Exam: 35**
Theory: 30 Lectures	**Total: 50**

Programming:

1. Exercises on syntax on usage of FORTRAN
2. Usage of GUI Windows, Linux Commands, familiarity with DOS commands and working in an editor to write sources codes in FORTRAN.
3. To print out all natural even/ odd numbers between given limits.
4. To find maximum, minimum and range of a given set of numbers.
5. Calculating Euler number using exp(x) series evaluated at x=1 (6 Lectures)

Hands on exercises:

1. To compile a frequency distribution and evaluate mean, standard deviation etc.
2. To evaluate sum of finite series and the area under a curve.
3. To find the product of two matrices
4. To find a set of prime numbers and Fibonacci series.
5. To write program to open a file and generate data for plotting using Gnuplot.
6. Plotting trajectory of a projectile projected horizontally.
7. Plotting trajectory of a projectile projected making an angle with the horizontally.
8. Creating an input Gnuplot file for plotting a data and saving the output for seeing on the screen. Saving it as an eps file and as a pdf file.
9. To find the roots of a quadratic equation.
10. Motion of a projectile using simulation and plot the output for visualization.
11. Numerical solution of equation of motion of simple harmonic oscillator and plot the outputs for visualization.
12. Motion of particle in a central force field and plot the output for visualization. (9 Lectures)

Reference Books:

- Introduction to Numerical Analysis, S.S. Sastry, 5th Edn., 2012, PHI Learning Pvt. Ltd.
- Computer Programming in Fortran 77". V. Rajaraman (Publisher:PHI).
- Gnuplot in action: understanding data with graphs, Philip K Janert, (Manning 2010)
- Schaum's Outline of Theory and Problems of Programming with Fortran, S Lipsdutz and A Poe, 1986Mc-Graw Hill Book Co.
- Computational Physics: An Introduction, R. C. Verma, etal. New Age International Publishers, New Delhi(1999)
- Elementary Numerical Analysis, K.E.Atkinson,3 rd Edn . , 2 007 , Wiley India Edition.

B.Sc.(H) Physics
Paper: ELECTRICAL CIRCUITS AND NETWORK SKILLS
Paper Code: SECP-02

No. of Credits: 2	**Sessional: 25**
L: 2, T: 0	**Theory Exam: 75**
Theory: 30 Lectures	**Total: 100**

Course Objectives: *The aim of this course is to enable the students to design and trouble shoots the electrical circuits, networks and appliances through hands-on mode.*

Basic Electricity Principles: Voltage, Current, Resistance, and Power. Ohm's law. Series, parallel, and series-parallel combinations. AC and DC Electricity. Familiarization with multimeter, voltmeter and ammeter. (3 Lectures)

Electrical Circuits: Basic electric circuit elements and their combination. Rules to analyze DC sourced electrical circuits. Single-phase and three-phase alternating current sources. Rules to analyze AC sourced electrical circuits. Real, imaginary and complex power components of AC source. Power factor. Saving energy and money. (5 Lectures)

Generators and Transformers: DC Power sources. AC/DC generators. Inductance, capacitance, and impedance. Operation of transformers. (4 Lectures)

Electric Motors: Single-phase, three-phase & DC motors. Basic design. Interfacing DC or AC sources to control heaters and motors. Speed & power of ac motor. (5Lectures)

Solid-State Devices: Resistors, inductors and capacitors. Components in Series or in shunt. Response of inductors and capacitors with DC or AC sources (2 Lectures)

Electrical Protection: Relays. Fuses and disconnect switches. Circuit breakers. Overload devices. Ground-fault protection. Grounding and isolating. Phase reversal. Surge protection. Relay protection device. (7 Lectures)

Electrical Wiring: Basics of wiring-Star and delta connection. Voltage drop and losses across cables and conductors. Insulation. Solid and stranded cable. Preparation of extension board. (4 Lectures)

Course Outcomes: After the completion of the course, students will be able to,

- Know the basic electrical circuits and their working principles
- Understand of working theory of Generators/Transformers and AC and DC motors.
- Learn the various passive components and their connections.
- Have an understanding of electrical wiring and electrical protection techniques.

Reference Books:

- Electrical Circuits, K.A. Smith and R.E. Alley, 2014, Cambridge University Press A text book in Electrical Technology - B L Theraja - S Chand & Co.
- A text book of Electrical Technology - A K Theraja
- Performance and design of AC machines - M G Say ELBS Edn.

B.Sc.(H) Physics
Paper: ELECTRICAL CIRCUITS AND NETWORK SKILLS Lab
Paper Code: SECP-05

No. of Credits: 0	**Sessional: 15**
L: 0, P: 2	**Theory Exam: 35**
Theory: 30 Lectures	**Total: 50**

Course Objective: *The aim of this lab course is to enable the students to design and trouble shoots the electrical circuits, networks and appliances through hands-on mode*

1. Use of multimeter to measure AC and DC Voltage and Current, Resistance, and Power.
2. Series, parallel, and series-parallel combinations

3. Ohm's law. Series, parallel, and series-parallel combinations.
4. DC Power sources. AC/DC generators. Inductance, capacitance, and impedance. Operation of transformers.
5. Resistors, inductors and capacitors. Diode, rectifiers and filters. Components in Series or in shunt.
6. Response of inductors and capacitors with DC or AC sources
7. Basics of wiring-Star and delta connection.
8. Preparation of extension board.

Reference Books:

- Electrical Circuits, K.A. Smith and R.E. Alley, 2014, Cambridge University Press
- A text book in Electrical Technology - B L Theraja - S Chand & Co.
- A text book of Electrical Technology - A K Theraja
- Performance and design of AC machines - M G Say ELBS Edn.

B.Sc.(H) Physics
Paper: BASIC INSTRUMENTATION SKILLS
Paper Code: SECP-03

No. of Credits: 2	**Sessional: 25**
L: 2, T: 0	**Theory Exam: 75**
Theory: 30 Lectures	**Total: 100**

Course Objective: *This course is to get exposure with various aspects of instruments and their usage through hands-on mode. Experiments listed below are to be done in continuation of the topics.*

Basic of Measurement: Instruments accuracy, precision, sensitivity, resolution range etc. Errors in measurements and loading effects. Multimeter: Principles of measurement of dc voltage and dc current, ac voltage, ac current and resistance. Specifications of a multimeter and their significance. (5 Lectures)

Electronic Voltmeter: Advantage over conventional multimeter for voltage measurement with respect to input impedance and sensitivity. Principles of voltage, measurement (block diagram only). Specifications of an electronic Voltmeter/ Multimeter and their significance. AC millivoltmeter: Type of AC millivoltmeters. Block diagram ac millivoltmeter, specifications and their significance. (5 Lectures)

Oscilloscope: Block diagram of basic CRO. CRT, electrostatic focusing and acceleration (Explanation only– no mathematical treatment), brief discussion on screen phosphor, visual persistence. Time base operation, synchronization. Front panel controls. Specifications of CRO and their significance. (6 Lectures)

Use of CRO for the measurement of voltage (dc and ac), frequency and time period. Special features of dual trace, introduction to digital oscilloscope, probes. Digital storage Oscilloscope: principle of working. (4 Lectures)

Impedance Bridges: Block diagram of bridge. working principles of basic (balancing type) RLC bridge. Specifications of RLC bridge. Block diagram and working principles of a Q- Meter. (3 Lectures)

Digital Instruments: Comparison of analog & digital instruments. Characteristics of a digital meter. Working principles of digital voltmeter. (3 Lectures)

Digital Multimeter: Block diagram and working of a digital multimeter. Working principle of time interval, frequency and period measurement using universal counter/ frequency counter, time- base stability, accuracy and resolution. (4 Lectures)

Course Outcomes: After the completion of the course, students will be able to,

- Know the basics of measurements, errors, use of multimeter.
- Learn the use of electronic voltmeter to measure AC and DC quantities.
- Understand the working theory and applications of CRO for measurements.
- Have an understanding of digital measuring tools and techniques.

Reference Books:

- A text book in Electrical Technology - B L Theraja - S Chand and Co. Performance and design of AC machines - M G Say ELBS Edn.
- Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill. Logic circuit design, Shimon P. Vingron, 2012, Springer.
- Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
- Electronic Devices and circuits, S. Salivahanan & N. S.Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill

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B.Sc.(H) Physics
Paper: BASIC INSTRUMENTATION SKILLS Lab
Paper Code: SECP-06

No. of Credits: 0	**Sessional: 15**
L: 0, P: 2	**Theory Exam: 35**
Theory: 30 Lectures	**Total: 50**

The test of lab skills will be of the following test items:

1. Use of an oscilloscope.
2. Oscilloscope as a versatile measuring device.
3. Circuit tracing of Laboratory electronic equipment,
4. Use of Digital multimeter/VTVM for measuring voltages
5. Circuit tracing of Laboratory electronic equipment,
6. Winding a coil / transformer.
7. Study the layout of receiver circuit.
8. Trouble shooting a circuit
9. Balancing of bridges

Laboratory Exercises:

1. To observe the loading effect of a multimeter while measuring voltage across a low resistance and high resistance.
2. To observe the limitations of a multimeter for measuring high frequency voltage and currents.
3. To measure Q of a coil and its dependence on frequency, using a Q- meter.
4. Measurement of voltage, frequency, time period and phase using Oscilloscope.
5. Measurement of time period, frequency, average period using universal counter/ frequency counter.
6. Measurement of rise, fall and delay times using a Oscilloscope.
7. Measurement of distortion of a RF signal generator using distortion factor meter.
8. Measurement of R,L and C using a LCR bridge/ universal bridge.

Open Ended Experiments:

1. Using a Dual Trace Oscilloscope
2. Converting the range of a given measuring instrument (voltmeter, ammeter)

Reference Books:

- A text book in Electrical Technology - B L Theraja - S Chand and Co. Performance and design of AC machines - M G Say ELBS Edn.
- Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill. Logic circuit design, Shimon P. Vingron, 2012, Springer.
- Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
- Electronic Devices and circuits, S. Salivahanan & N. S.Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill

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Syllabus of B.Sc. (H) Physics

Semester V

Discipline Core Course (DCC)

B.Sc.(H) Physics Sem-V
Paper: QUANTUM MECHANICS AND APPLICATIONS
Paper Code: BPH-501

No. of Credits: 4	**Sessional: 25**
L: 4, T: 0	**Theory Exam: 75**
Theory: 60 Lectures	**Total: 100**

Course Objectives: In continuation with modern physics this course is an application of Schrodinger equation to various quantum mechanical problems. This gives fair idea of formulation of eigenvalues and eigen functions.

Time dependent Schrodinger equation: Time dependent Schrodinger equation and dynamical evolution of a quantum state; Properties of Wave Function. Interpretation of Wave Function Probability and probability current densities in three dimensions; Conditions for Physical Acceptability of Wave Functions. Normalization. Linearity and Superposition Principles. Eigenvalues and Eigenfunctions. Position, momentum and Energy operators; commutator of position and momentum operators; Expectation values of position and momentum. Wave Function of a Free Particle. **(15 Lectures)**

Time independent Schrodinger equation-Hamiltonian, stationary states and energy eigen values; expansion of an arbitrary wave function as a linear combination of energy eigen functions; General solution of the time dependent Schrodinger equation in terms of linear combinations of stationary states; Application to spread of Gaussian wave-packet for a free particle in one dimension; wave packets, Fourier transforms and momentum space wave function; Position-momentum uncertainty principle. **(15 Lectures)**

General discussion of bound states in an arbitrary potential- continuity of wave function, boundary condition and emergence of discrete energy levels; application to one-dimensional problem-square well potential; potential barrier, reflection and refraction; Quantum mechanics of simple harmonic oscillator-energy levels and energy eigen functions using Frobenius method; Hermite polynomials; ground state, zero point energy & uncertainty principle. **(15 Lectures)**

Quantum theory of hydrogen-like atoms and Angular momentum: time independent Schrodinger equation in spherical polar coordinates; separation of variables for second order partial differential equation; angular momentum operator & quantum numbers; Radial wavefunctions from

Frobenius method; shapes of the probability densities for ground and first excited states; Orbital angular momentum quantum numbers l and m; s, p, d shells. Electron angular momentum. Angular momentum quantization. Electron Spin and Spin Angular Momentum. Total angular momentum. Pauli spin matrices and their properties. **(15 Lectures)**

COURSE OUTCOME

On successful completion of this course, students should be able to:

- Understand the time dependent Schrodinger equation and its applications.
- Understand the time independent Schrodinger equation and its applications.
- Apply their knowledge of quantum mechanics to study bound states potentials.
- Understand the theory of Angular Momentum and its application in quantum mechanics.

Reference Books:

- A Text book of Quantum Mechanics, P.M.Mathews and K.Venkatesan, 2nd Ed., 2010, McGraw Hill
- Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn., 2002, Wiley.
- Quantum Mechanics, Leonard I. Schiff, 3rd Edn. 2010, Tata McGraw Hill.
- Quantum Mechanics for Scientists & Engineers, D.A.B. Miller, 2008, Cambridge University Press
- Quantum Mechanics, Eugen Merzbacher, 2004, John Wiley and Sons, Inc.
- Introduction to Quantum Mechanics, D.J. Griffith, 2nd Ed. 2005, Pearson Education

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B.Sc.(H) Physics Sem-V
Paper: QUANTUM MECHANICS AND APPLICATIONS Lab
Paper Code: BPH-503

No. of Credits: 2	**Sessional: 15**
L: 0, P: 4	**External Exam: 35**
Lab: 60 Periods	**Total: 50**

Use C/C++/Scilab for solving the following problems based on Quantum Mechanics like

1. Solve the s-wave Schrodinger equation for the ground state and the first excited state of the hydrogen atom:

$$\frac{d^2y}{dr^2} = A(r).u(r), \quad A(r) = \frac{2m}{\hbar^2}[V(r) - E] \text{ where } V(r) = -\frac{e^2}{r}$$

Here, m is the reduced mass of the electron. Obtain the energy eigenvalues and plot the corresponding wave functions. Remember that the ground state energy of the hydrogen atom is approximately -13.6 eV. Take e = 3.795 $(eVÅ)^{1/2}$, ħc = 1973 (eVÅ) and m = 0.511×10^6 eV/c^2.

2. Solve the s-wave radial Schrodinger equation for an atom:

$$\frac{d^2y}{dr^2} = A(r).u(r), \quad A(r) = \frac{2m}{\hbar^2}[V(r) - E]$$

where m is the reduced mass of the system (which can be chosen to be the mass of an electron), for the screened coulomb potential

$$V(r) = -\frac{e^2}{r}e^{-r/a}$$

Find the energy (in eV) of the ground state of the atom to an accuracy of three significant digits. Also, plot the corresponding wave function. Take e = 3.795 $(eVÅ)^{1/2}$, m = 0.511×10^6 eV/c^2, and a = 3 Å, 5 Å, 7 Å. In these units ħc = 1973 (eVÅ). The ground state energy is expected to be above -12 eV in all three cases.

3. Solve the s-wave radial Schrodinger equation for a particle of mass m:

$$\frac{d^2y}{dr^2} = A(r).u(r), \quad A(r) = \frac{2m}{\hbar^2}[V(r) - E]$$

For the anharmonic oscillator potential

$$V(r) = \frac{1}{2}kr^2 + \frac{1}{3}br^3$$

for the ground state energy (in MeV) of particle to an accuracy of three significant digits. Also, plot the corresponding wave function. Choose m = 940 MeV/c^2, k = 100 MeV fm^{-2}, b = 0, 10, 30 MeV fm^{-3}. In these units, cħ = 197.3 MeV fm. The ground state energy I expected to lie between 90 and 110 MeV for all three cases.

4. Solve the s-wave radial Schrodinger equation for the vibrations of hydrogen molecule:

$$\frac{d^2y}{dr^2} = A(r).u(r), \quad A(r) = \frac{2m}{\hbar^2}[V(r) - E]$$

Where m is the reduced mass of the two-atom system for the Morse potential

$$V(r) = D(e^{-2\alpha r'} - e^{-\alpha r'}), \quad r' = \frac{r - r_o}{r}$$

Find the lowest vibrational energy (in MeV) of the molecule to an accuracy of three significant digits. Also plot the corresponding wave function.

Take: m = $940 \times 10^6 eV/C^2$, D = 0.755501 eV, α = 1.44, r_o = 0.131349 Å

5. Solution of Ordinary Differential Equations (ODE)

First order Differential equation Euler, modified Euler and Runge-Kutta (RK) second and fourth order methods

(a) First order differential equation

- Radioactive decay
- Current in RC, LC circuits with DC source
- Newton's law of cooling
- Classical equations of motion

(b) Attempt following problems using RK 4 order method:

- Solve the coupled differential equations

$dx/dt = y + x - x^3/3$; $dy/dx = - x$

for four initial conditions x(0) = 0, y(0) = -1, -2, -3, -4.

Plot x vs y for each of the four initial conditions on the same screen for $0 \leq t \leq 15$.

Reference Books:

- Schaum's outline of Programming with C++.J.Hubbard, 20 00, McGraw-Hill Publication
- An introduction to computational Physics, T.Pang, 2nd Edn.,2006, Cambridge Univ. Press
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific & Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández.2014 Springer.
- Scilab (A Free Software to Matlab): H. Ramchandran, A.S. Nair. 2011 S. Chand & Co

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B.Sc.(H) Physics Sem-V
Paper: SOLID STATE PHYSICS
Paper Code: BPH-502

No. of Credits: 4	**Sessional: 25**
L: 4, T: 0	**Theory Exam: 75**
Theory: 60 Lectures	**Total: 100**

Course Objectives: This syllabus gives an introduction to the basic phenomena in Solid State Physics. This aims to provide a general introduction to theoretical and experimental topics in solid state physics. On successful completion of the module students should be able to elucidate the main features of crystal lattices and phonons, understand the elementary lattice dynamics and its influence on the properties of materials, describe the main features of the physics of electrons in solids; explain the dielectric ferroelectric and magnetic properties of solids and understand the basic concept in superconductivity.

Crystal Structure: Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors.Lattice with a Basis– Central and Non-Central Elements.Symmetry Elements Unit Cell. Miller Indices. Reciprocal Lattice. Bravais Lattices, SC, BCC, FCC, HCP Types of Lattices. Crystal structures of NaCl, ZnS, Diamond. Brillouin Zones. **(8 Lectures)**

Diffraction of X-rays by Crystals. Bragg‟s Law. Laue conditions. Atomic and Scattering Factor SC, BCC, FCC, NaCl, ZnS, Diamond. (**8 Lectures)**

Elementary Lattice Dynamics: Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains. Acoustical and Optical Phonons. Einstein and Debye theories of specific heat of solids. T^3 law. **(8 Lectures)**

Electrons in Solids: Density of states (1-D,2-D,3-D), Elementary band theory:Kronig Penny model (no derivation; Qualitative description only). Band Gap., Effective mass, Hall Effect (Metal and Semiconductor). **(8 Lectures)**

Magnetic Properties of Matter: Dia-, Para-, Ferri- and Ferromagnetic Materials. Classical Langevin Theory of dia– and Paramagnetic Domains. Curie‟s law, Weiss‟s Theory of Ferromagnetism and Ferromagnetic Domains, B-H Curve.Hysteresis, soft and hard material and Energy Loss. **(8 Lectures)**

Dielectric Properties of Materials: Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius Mosotti Equation. Normal and Anomalous Dispersion. Complex Dielectric Constant. **(10 Lectures)**

Ferroelectric Properties of Materials: Classification of crystals, Piezoelectric effect, Pyroelectric effect, Ferroelectric effect, Electrostrictive effect, Curie-Weiss Law, Ferroelectric domains, PE hysteresis loop. **(5 lectures)**

Superconductivity: Experimental Results. Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors, London‟s Equation and Penetration Depth. Isotope effect. Idea of BCS theory (No derivation) **(5 Lectures)**

COURSE OUTCOME

On successful completion of this course, students should be able to:

- Understand the crystal structure and lattice dynamics.
- Understand the band theory of solids.
- Learn the magnetic properties of solids.
- Understand the dielectric and ferroelectric properties of solids
- Understand the Superconductivity and its theories

Reference Books:

- Introduction to Solid State Physics, Charles Kittel, 8th Edn., 2004, Wiley India Pvt. Ltd.
- Elements of Solid State Physics, J.P. Srivastava, 2nd Edn., 2006, Prentice-Hall of India.
- Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill.
- Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning.
- Solid-state Physics, H.Ibach and H. Luth, 2009, Springer.
- Solid State Physics, Rita John, 2014, McGraw Hill
- Solid State Physics, M.A. Wahab, 2011, Narosa Publications.

B.Sc.(H) Physics Sem-V
Paper: Solid State Physics Lab
Paper Code: BPH-504

No. of Credits: 2 **Sessional: 15**
L: 0, P: 4 **External Exam: 35**
Lab: 60 Periods **Total: 5**

At least 06 experiments from the following

1. Measurement of susceptibility of paramagnetic solution (Quinck`s Tube Method)
2. To measure the Magnetic susceptibility of Solids.
3. To determine the Coupling Coefficient of a Piezoelectric crystal.
4. To measure the Dielectric Constant of a dielectric Materials with frequency.
5. To determine the complex dielectric constant and plasma frequency of metal using Surface Plasmon resonance (SPR) technique.
6. To determine the refractive index of a dielectric using SPR technique.
7. To study the PE Hysteresis loop of a Ferroelectric Crystal.
8. To draw the BH curve of Fe using Solenoid & determine energy loss from Hysteresis.
9. To measure the resistivity of a semiconductor (Ge) with temperature (up to 150^{o}C) by four-probe method and to determine its band gap.
10. To determine the Hall coefficient of a semiconductor sample.
11. To measure the resistivity of a semiconductor (Ge) with temperature by two-probe method and to determine its band gap.
12. Analysis of X-Ray diffraction data in terms of unit cell parameters and estimation of particle size.
13. Measurement of change in resistance of a semiconductor with magnetic field.

Reference Books:

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
- A Text Book of Practical Physics, I.Prakash& Ramakrishna, 11th Ed., 2011, Kitab Mahal
- Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India.

Discipline Elective Course in Physics (DECP)
Semester-V

Select any two papers and corresponding lab (if any)

B.Sc.(H) Physics Sem-V
Paper: Atomic and Molecular Physics
Paper Code: DECP-501

No. of Credits: 6 — **Sessional: 25**
L: 5, T: 1 — **Theory Exam: 75**
Theory: 75 Lectures — **Total: 100**

COURSE OBJECTIVE: To understand the fundamentals of atomic and molecular physics. To provide a coherent and concise coverage of traditional atomic and molecular physics

General Atomic Theory: Determination of e/m of the Electron, Thompson, Helical Focussing method. Thermionic Emission, Dussmann's equation **(6 Lectures)**

X-rays :- Ionizing Power, Bohr Atomic Model, Critical Potentials, X-rays-Spectra: Continuous and Characteristic X-rays, Moseley Law. (**6 Lectures)**

Atoms in Electric and Magnetic Fields :- Electron Angular Momentum. Space Quantization. Electron Spin and Spin Angular Momentum. Larmor's Theorem. Spin Magnetic Moment. Stern-Gerlach Experiment. Zeeman Effect: Electron Magnetic Moment and Magnetic Energy, Gyromagnetic Ratio and Bohr Magneton. **(10 Lectures)**

Atoms in External Magnetic Fields :- Normal and Anomalous Zeeman Effect. Paschen Back and Stark Effect (Qualitative Discussion only). **(8 Lectures)**

Many electron atoms :- Pauli's Exclusion Principle. Symmetric and Antisymmetric Wave Functions. Periodic table. Fine structure. Spin orbit coupling. Spectral Notations for Atomic States. Total Angular Momentum. Vector Model. L-S and J-J couplings. Hund's Rule. Term symbols. Spectra of Hydrogen and Alkali Atoms (Na etc.). (**15 Lectures)**

Molecular Spectra :- Derivation of Rotational Energy levels, Selection Rules and Pure Rotational Spectra of a Molecule. Derivation of Vibrational Energy Levels, Selection Rules and Vibration Spectra. Rotation-Vibration Energy Levels, Selection Rules and Rotation-Vibration Spectra. Determination of Internuclear Distance. **(15 Lectures)**

Raman Effect :- Quantum Theory of Raman Effect. Characteristics of Raman Lines. Stoke's and Anti-Stoke's Lines. Complimentary Character of Raman and infrared Spectra. **(8 Lectures)**

Lasers :- Einstein's A and B coefficients. Metastable states. Spontaneous and Stimulated emissions. Optical Pumping and Population Inversion. Three-Level and Four-Level Lasers. Ruby Laser and He-Ne Laser. **(7 Lectures)**

COURSE OUTCOME

On successful completion of this course, students should be able to:

- Understand the fundamental aspects of atomic Physics.
- Understand the behavior of atoms in electric and magnetic fields
- Understand the rotational, vibrational molecular structure.
- Learn the Raman effect for structure determination of molecules
- Learn the fundamentals of Lasing action and some lasers.

Suggested Books:

1. Concepts of Modern Physics by Arthur Beiser (McGraw-Hill Book Company, 1987)
2. Atomic physics by J.B.Rajam & foreword by Louis De Broglie.(S.Chand & Co., 2007).
3. Atomic Physics by J.H.Fewkes & John Yarwood. Vol. II (Oxford Univ. Press, 1991).
4. Physics of Atoms and Molecules, Bransden and Joachein.
5. Molecular Spectroscopy, Banwell.
6. Optoelectronics by Ghatak and Thyagarajan
7. Principles of Lasers by Svelto

B.Sc.(H) Physics Sem-V

Paper: EXPERIMENTAL TECHNIQUES

Paper Code: DECP-502

No. of Credits: 4	**Sessional: 25**
L: 4T: 0	**Theory Exam: 75**
Theory: 60 Lectures	**Total: 100**

Course Objectives: This paper aims to describe the errors in measurement and statistical analysis of data required while performing an experiment. Also, students will learn the working principle, efficiency and applications of transducers & industrial instruments like digital multimeter, RTD, Thermistor, Thermocouples and Semiconductor type temperature sensors.

Measurements: Accuracy and precision. Significant figures. Error and uncertainty analysis. Types of errors: Gross error, systematic error, random error. Statistical analysis of data (Arithmetic mean, deviation from mean, average deviation, standard deviation, chi-square) and curve fitting. Gaussian distribution. **(7 Lectures)**

Signals and Systems: Fluctuations and Noise in measurement system. S/N ratio and Noise figure. Noise in frequency domain. Sources of Noise: Inherent fluctuations, Thermal noise, Shot noise, 1/f noise **(3 Lectures)**

Shielding and Grounding: Methods of safety grounding. Energy coupling. Grounding. Shielding: Electrostatic shielding. Electromagnetic Interference. **(4 Lectures)**

Transducers & industrial instrumentation (working principle, efficiency, applications): Static and dynamic characteristics of measurement Systems. Generalized performance of systems, Zero order first order, second order and higher order systems. Electrical, Thermal and Mechanical systems. Calibration. Qualitative difference between Transducers and sensors.Types of sensors (Physical, Chemical and Biological), Characteristics of Transducers.Transducers as electrical element and their signal conditioning. Temperature transducers: RTD, Thermistor, Thermocouples, Semiconductor type temperature sensors (AD590, LM35, LM75) and signal conditioning. Linear Position transducer: Strain gauge, Piezoelectric. Inductance change transducer: Linear variable differential transformer (LVDT), Capacitance change transducers. Radiation Sensors: Principle of Gas filled detector, ionization chamber, scintillation detector. **(21 Lectures)**

Digital Multimeter: Comparison of analog and digital instruments. Block diagram of digital multimeter, principle of measurement of I, V, C. Accuracy and resolution of measurement.

(5 Lectures)

Impedance Bridges and Q-meter: Block diagram and working principles of RLC bridge. Q-meter and its working operation. Digital LCR bridge. **(4 Lectures)**

Vacuum Systems: Characteristics of vacuum: Gas law, Mean free path. Application of vacuum. Vacuum system- Chamber with roughing and backing, Mechanical pumps (Rotary and root pumps), Diffusion pump & Turbo Molecular pump, Ion pumps, Pumping speed, throughput, Pressure gauges (Pirani, Penning, ionization, cold cathode). **(16 Lectures)**

COURSE OUTCOME

On successful completion of this course, students should be able to:

- Understand the basics of measurements and error analysis.
- Understand the fundamentals of transducers and industrial instruments.
- Learn the working of digital multimeter and impedence bridges.
- Understand the theory and working of various vacuum systems.

Reference Books:

- Experimental Methods for Engineers, J.P. Holman, McGraw Hill
- Introduction to Measurements and Instrumentation, A.K. Ghosh, 3rd Edition, PHI Learning Pvt. Ltd.

- Transducers and Instrumentation, D.V.S. Murty, 2nd Edition, PHI Learning Pvt. Ltd.
- Instrumentation Devices and Systems, C.S.Rangan, G.R. Sarma, V.S.V. Mani, Tata McGraw Hill
- Electronic circuits: Handbook of design & applications, U.Tietze, Ch.Schenk, Springer

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B.Sc.(H) Physics Sem-V
Paper: Linear Algebra & Tensor Analysis
Paper Code: DECP-503

No. of Credits: 6	**Sessional: 25**
L: 5, T: 1	**Theory Exam: 75**
Theory: 75 Lectures	**Total: 100**

Course Objectives: The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.

Linear Vector Spaces Abstract Systems: Binary Operations and Relations. Introduction to Groups and Fields. Vector Spaces and Subspaces. Linear Independence and Dependence of Vectors. Basis and Dimensions of a Vector Space. Change of basis. Homomorphism and Isomorphism of Vector Spaces. Linear Transformations. Algebra of Linear Transformations. Non-singular Transformations. Representation of Linear Transformations by Matrices. **(12 Lectures)**

Matrices, Addition and Multiplication of Matrices: Null Matrices. Diagonal, Scalar and Unit Matrices. Upper-Triangular and Lower-Triangular Matrices. Transpose of a Matrix. Symmetric and Skew-Symmetric Matrices. Conjugate of a Matrix. Hermitian and Skew-Hermitian Matrices. Singular and Non-Singular matrices. Orthogonal and Unitary Matrices & their properties. Trace of a Matrix. Inner product of vectors. **(12 Lectures)**

Eigen-values and Eigenvectors: Finding Eigen – values and Eigen vectors of a Matrix. Diagonalization of Matrices. Properties of Eigen-values and Eigen Vectors of Orthogonal, Hermitian and Unitary Matrices. Cayley-Hamiliton Theorem(Statement only).Finding inverse of a matrix using Cayley-Hamiltion Theorem. Solutions of ordinary second order differential equations and Coupled Linear Ordinary Differential Equations of first order. Functions of a Matrix. **(12 Lectures)**

Transformation of Co-ordinates and fundamentals of Tensors. Einstein's Summation Convention. Relation between Direction Cosines. Tensors. Algebra of Tensors. Sum, Difference and Product of Two Tensors. Contraction. Quotient Law of Tensors. Symmetric and Anti-symmetric Tensors. Invariant Tensors : Kronecker and Alternating Tensors. Association of Antisymmetric Tensor of Order Two and Vectors. **(12 lectures)**

Cartesian Tensors: Vector Algebra and Calculus using Cartesian Tensors : Scalar and Vector Products, Scalar and Vector Triple Products. Differentiation. Gradient, Divergence and Curl of Tensor Fields. Tensor notation of Laplacian operator. Proof of Vector Identities involving scalar and vector products and vector identities involving Del operator under Tensor notation. Isotropic Tensors (Definition only). Tensorial Character of Physical Quantities. Moment of Inertia Tensor. Stress and Strain Tensors : Symmetric Nature. Elasticity Tensor. Generalized Hooke‟s Law. **(15 lectures)**

General Tensors Transformation of Co-ordinates. Minkowski Space. Contravariant & Covariant Vectors. Contravariant, Covariant and Mixed Tensors. Kronecker Delta and Permutation Tensors. Algebra of Tensors. Sum, Difference & Product of Two Tensors. Contraction. Quotient Law of Tensors. Symmetric and Anti-symmetric Tensors. Metric Tensor. **(12 Lectures)**

COURSE OUTCOME

On successful completion of this course, students should be able to:

- Understand the linear algebra and fundamentals of matrices.
- Determine the eigen values and eigen vectors of matrices and their properties.
- Understand the transformation of coordinates and fundamentals of Tensors.
- Learn the Cartesion Tensors and the general algebra of tensors.

Reference Books:

- Mathematical Tools for Physics, James Nearing, 2010, Dover Publications
- Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber and F.E.Harris,1970, Elsevier.
- Modern Mathematical Methods for Physicists and Engineers, C.D. Cantrell, 2011, Cambridge University Press
- Introduction to Matrices & Linear Transformations, D.T.Finkbeiner,1978, Dover Pub.
- Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole

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BSc (H) Physics Sem-V
Paper: EXPERIMENTAL TECHNIQUES Lab
Paper Code: DECP-504

No. of Credits: 2 **Internal: 15**
L: 0, T: 0, P: 4 **External Exam: 35**
60 Periods **Total: 50**

At least 06 experiments each from the following:

1. Determine output characteristics of a LVDT & measure displacement using LVDT
2. Measurement of
   (a) Strain using Strain Gauge,
   (b) level using capacitive transducer.
   (c) distance using ultrasonic transducer
3. To study the characteristics of a Thermostat and determine its parameters.
4. Calibrate Semiconductor type temperature sensor (AD590, LM35, LM75) and Resistance Temperature Device (RTD).
5. Create vacuum in a small chamber using a mechanical (rotary) pump and measure the chamber pressure using a pressure gauge.
6. Comparison of pickup of noise in cables of different types (co-axial, single shielded, double shielded, without shielding) of 2mlength, understanding of importance of grounding using function generator of mV level & an oscilloscope.
7. To design and study the Sample and Hold Circuit.
8. Design and analyze the Clippers and Clampers circuits using junction diode
9. To plot the frequency response of a microphone.
10. To measure Q of a coil and influence of frequency, using a Q-meter.

Reference Books:

- Electronic circuits: Handbook of design and applications, U.Tietze and C.Schenk, 2008, Springer
- Basic Electronics:A text lab manual, P.B.Zbar, A.P.Malvino, M.A.Miller, 1990, Mc-Graw Hill
- Measurement, Instrumentation and Experiment Design in Physics & Engineering, M.Sayer and A. Mansingh, 2005, PHI Learning.

B.Sc.(H) Physics Sem-V
Paper: Biological & Medical Physics
Paper Code: DECP-505

No. of Credits: 6 | **Sessional: 25**
L: 5, T: 1 | **Theory Exam: 75**

Theory: 75 Lectures | Total: 100

Course Objectives: The Biological Physics course introduces the emerging inter-disciplinary field on the interface of Physics and Biology. It makes use of concepts from Physics and discusses their application in Biology. This course helps the students to develop a system level perspective of Biology and equips them with the required mathematical and computational skills.

Overview: The boundary, interior and exterior environment of living cells. Processes: exchange of matter and energy with environment, metabolism, maintenance, reproduction, evolution. Self-replication as a distinct property of biological systems. Time scales and spatial scales. Allometric scaling laws. (6 Lectures)

Molecules of life: Metabolites, proteins and nucleic acids. Their sizes, types and roles in structures and processes. Transport, energy storage, membrane formation, catalysis, replication, transcription, translation, signaling. Typical populations of molecules of various types present in cells, their rates of production and turnover. Energy required to make a bacterial cell. small genetic circuits and signaling pathways (overview only). (12 Lecture)

Molecular motion in cells: Random walks and applications to biology: Diffusion; models of macromolecules. Entropic forces: Osmotic pressure; polymer elasticity. Chemical forces: Self assembly of amphiphiles. Molecular motors: Transport along microtubules. (17 Lectures)

Brain structure: neurons and neural networks. Brain as an information processing system. At the level of an ecosystem and the biosphere: Foodwebs. Feedback cycles and self sustaining ecosystems. (8 Lectures)

Evolution: The mechanism of evolution: variation at the molecular level, selection at the level of the organism. Models of evolution. The concept of genotype-phenotype map. Examples. (9 Lectures)

Physics of The Body: Acoustics of the body: Nature and characteristics of sound, Production of speech, Physics of the ear, Diagnostics with sound and ultrasound. Optical system of the body: Physics of the eye. Electrical system of the body: Physics of the nervous system, Electrical signals and information transfer. Physics of cardiovascular system. Basics of CPR (15 Lectures)

Physics of Diagnostic And Therapeutic Systems: Diagnostic nuclear medicine: Radiopharmaceuticals for radioisotope imaging, Radioisotope imaging equipment, Single photon and positron emission tomography. Therapeutic nuclear medicine: Interaction between radiation and matter Dose and isodose in radiation treatment. Medical Instrumentation: Basic Ideas of

Endoscope and Cautery, Sleep Apnea and Cpap Machines, Ventilator and its modes. (8 Lectures)

Reference Books:

- Biological Physics: Energy, Information, Life; Philip Nelson (W H Freeman• &Co, NY, 2004)
- Physical Biology of the Cell (2nd Edition); Rob Phillips et al (Garland Science,• Taylor & Francis Group, London & NY, 2013)
- An Introduction to Systems Biology; Uri Alon (Chapman and Hall/CRC, Special• Indian Edition, 2013) Evolution; M. Ridley (Blackwell Publishers, 2009, 3rd edition)
- Medical Physics, J.R. Cameron and J.G.Skofronick, Wiley (1978)
- Basic Radiological Physics Dr. K.Thayalan- Jayapee Brothers Medical Publishing Pvt.• Ltd. New Delhi (2003)
- Christensen‟s Physics of Diagnostic Radiology: Curry, Dowdey and Murry - Lippincot• Williams and Wilkins (1990)
- Physics of the human body, Irving P. Herman, Springer (2007).
- Physics of Radiation Therapy: F M Khan - Williams and Wilkins, 3rdedition (2003)
- The essential physics of Medical Imaging: Bushberg, Seibert, Leidholdt and Boone• Lippincot Williams and Wilkins, Second Edition (2002)
- Handbook of Physics in Diagnostic Imaging: R.S.Livingstone: B.I. Publication Pvt Ltd.
- The Physics of Radiology-H E Johns and Cunningham.

Syllabus of B.Sc. (H) Physics

Semester VI

Discipline Core Course (DCC)

B.Sc.(H) Physics Sem-VI
Paper: ELECTROMAGNETIC THEORY
Paper Code: BPH-601

No. of Credits: 4 | **Sessional: 25**
L: 4, T: 0 | **Theory Exam: 75**
Theory: 60 Lectures | **Total: 100**

Electromagnetic theory is a core course in B. Sc. (Honours) Physics curriculum. The course covers Maxwell's equations, propagation of electromagnetic (em) waves in different homogeneous-isotropic as well as anisotropic unbounded and bounded media, production and detection of different types of polarized em waves, general information as waveguides and fibre optics.

Maxwell Equations: Review of Maxwell's equations. Displacement Current. Vector and Scalar Potentials. Gauge Transformations: Lorentz and Coulomb Gauge. Poynting Theorem and Poynting Vector. Electromagnetic (EM) Energy Density. Physical Concept of Electromagnetic Field Energy Density. Momentum Density and Angular Momentum Density.
(12 Lectures)

EM Wave Propagation in Unbounded Media: Plane EM waves through vacuum and isotropic dielectric medium, transverse nature of plane EM waves, refractive index and dielectric constant, wave impedance. Propagation through conducting media, relaxation time, skin depth. Wave propagation through dilute plasma, electrical conductivity of ionized gases, plasma frequency, refractive index, skin depth, application to propagation through ionosphere. **(12 Lectures)**

EM Wave in Bounded Media: Boundary conditions at a plane interface between two media. Reflection & Refraction of plane waves at plane interface between two dielectric media-Laws of Reflection & Refraction. Fresnel's Formulae for perpendicular & parallel polarization cases, Brewster's law. Reflection & Transmission coefficients. Total internal reflection, evanescent waves. Metallic reflection (normal Incidence) **(12 Lectures)**

Polarization of Electromagnetic Waves: Description of Linear, Circular and Elliptical Polarization. Propagation of E.M. Waves in Anisotropic Media. Uniaxial and Biaxial Crystals.

Light Propagation in Uniaxial Crystal. Double Refraction. Polarization by Double Refraction. Nicol Prism. Ordinary & extraordinary refractive indices. Production & detection of Plane, Circularly and Elliptically Polarized Light. **(12 Lectures)**

Wave Guides: Planar optical wave guides. Wave equations for circular and rectangular hollow waveguides. TE, TM and TEM modes in rectangular wave guides. Condition of continuity at interface. Concept of cutoff frequency. Phase and group velocity of guided waves. **(9 Lectures)**

Optical Fibres: Numerical Aperture. Step and Graded Indices (Definitions Only). Single and Multiple Mode Fibres. **(3 Lectures)**

COURSE OUTCOMES

Students who have completed this course should

- Have a deep understanding of Maxwell's electromagnetic theory and propagation of EM waves though various media.
- Be able to understand the phenomena of reflection, refraction, polarization and dispersion of EM waves in bound media.
- Understand the polarization of electromagnetic waves.
- Be able to understand the concepts of waveguides and optical fibres.

Reference Books:

- Introduction to Electrodynamics, D.J. Griffiths, 3rd Ed., 1998, Benjamin Cummings.
- Electromagnetic Field and Waves, P. Lorrain and D. Corson, 2nd Ed., 2003, CBS Publisher.
- Elements of Electromagnetics, M.N.O. Sadiku, 2001, Oxford University Press.
- Fundamentals of Electromagnetics, M.A.W. Miah, 1982, Tata McGraw Hill
- Electromagnetic field Theory, R.S. Kshetrimayun, 2012, Cengage Learning
- Engineering Electromagnetic, Willian H. Hayt, 8th Edition, 2012, McGraw Hill.
- Electromagnetics, J.A. Edminster, Schaum Series, 2006, Tata McGraw Hill.
- Electromagnetic field theory fundamentals, B.Guru and H.Hiziroglu, 2015, Cambridge University Press
- Classical Electrodynamics, J.D. Jackson, 3rd Edn., 2010, Wiley
- Principle of Optics, M. Born and E. Wolf, 6th Edn., 1980, Pergamon Press
- Optics, A. Ghatak, 5th Edn., 2012, Tata McGraw Hill Education.

B.Sc.(H) Physics Sem-VI
Paper: Electromagnetic theory Lab
Paper Code: BPH-603

No. of Credits: 2	**Sessional: 15**
L: 0, P: 4	**External Exam: 35**
Lab: 60 Periods	**Total: 50**

The laboratory content compliments the theoretical knowledge of Electromagnetic Theory and gives hands-on experience. Also, it provides the observational understanding of the subject. It enhances the qualitative and quantitative skills of the students.

At least 06 experiments from the following

1. To verify the law of Malus for plane polarized light.
2. To determine the specific rotation of sugar solution using Polarimeter.
3. To analyze elliptically polarized Light by using a Babinet"s compensator.
4. To study dependence of radiation on angle for a simple Dipole antenna.
5. To determine the wavelength and velocity of ultrasonic waves in a liquid (Kerosene Oil, Xylene, etc.) by studying the diffraction through ultrasonic grating.
6. To study the reflection, refraction of microwaves
7. To study Polarization and double slit interference in microwaves.
8. To determine the refractive index of liquid by total internal reflection using Wollaston"s air-film.
9. To determine the refractive Index of (1) glass and (2) a liquid by total internal reflection using a Gaussian eyepiece.
10. To study the polarization of light by reflection and determine the polarizing angle for air-glass interface.
11. To verify the Stefan`s law of radiation and to determine Stefan"s constant.
12. To determine Boltzmann constant using V-I characteristics of PN junction diode.
13. To find Numerical Aperture of an Optical Fibre.
14. To verify Brewster"s Law and to find the Brewster"s angle.

Reference Books:

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer

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B.Sc.(H) Physics Sem-VI
Paper: STATISTICAL MECHANICS
Paper Code: BPH-602

No. of Credits: 4 **Sessional: 25**
L: 4, T: 0 **Theory Exam: 75**
Theory: 60 Lectures **Total: 100**

Course Objectives: The Statistical Mechanics deals with the derivation of the macroscopic parameters (internal energy, pressure, specific heat etc.) of a physical system consisting of large number of particles (solid, liquid or gas) from knowledge of the underlying microscopic behavior of atoms and molecues that comprises it. The main objective of this course work is to introduce the techniques of Statistical Mechanics which has applications in various fields including Astrophysics, Semiconductors, Plasma Physics, Bio-Physics, Chemistry and in many other directions.

Unit I : Classical Statistics

Macrostate and Microstate, Phase Space, Elementary Concept of Ensemble, Entropy and Thermodynamic Probability, Maxwell-Boltzmann Distribution Law, Partition Function, Thermodynamic Functions of an Ideal Gas, Classical Entropy Expression, Gibbs Paradox, Sackur-Tetrode equation, Law of Equipartition of Energy (with proof)– Applications to Specific Heat and its Limitations, Thermodynamic Functions of a Two-Energy Levels System, Negative Temperature. **(18 Lectures)**

Unit II:Bose-Einstein Statistics:

B-E distribution law, Thermodynamic functions of a strongly Degenerate Bose Gas, Bose Einstein condensation, properties of liquid He (qualitative description), Radiation as a photon gas and Thermodynamic functions of photon gas. Bose derivation of Planck‟s law. **(13 Lectures)**

Unit III:Fermi-Dirac Statistics:

Fermi-Dirac Distribution Law, Thermodynamic functions of a Completely and strongly Degenerate Fermi Gas, Fermi Energy, Electron gas in a Metal, Specific Heat of Metals, Relativistic Fermi gas, White Dwarf Stars, Chandrasekhar Mass Limit. **(15 Lectures)**

Unit IV : Theory of Radiation

Properties of Thermal Radiation. Blackbody Radiation. Pure temperature dependence. Radiation Pressure. Kirchhoff‟s law. Stefan-Boltzmann law: Thermodynamic proof. Wien‟s Displacement law. Wien‟s Distribution Law. Saha‟s Ionization Formula. Rayleigh-Jean‟s Law. Ultraviolet

Catastrophe. Spectral Distribution of Black Body Radiation. Planck‟s Quantum Postulates. Planck‟s Law of Blackbody Radiation: Experimental Verification. Deduction of (1) Wien‟s Distribution Law, (2) Rayleigh-Jeans Law, (3) Stefan-Boltzmann Law, (4) Wien‟s Displacement law from Planck‟s law. **(14 Lectures)**

COURSE OUTCOME

On successful completion of this course, students should be able to:

- Have a understanding of classical statistics of Maxwell-Boltzmann and its applications.
- Understand the quantum statistics of Bose-Einstein and its applications.
- Understand the Fermi-Dirac statistics and its applications.
- Have a basic understanding theory of radiations.

Reference Books:

- Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.
- Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill
- Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.
- An Introduction to Statistical Mechanics & Thermodynamics, R.H.Swendsen, 2012, Oxford Univ. Press
- Statistical Physics , F. Mandl, 2nd Edn., 2003, Wiley
- Introductory Statistical Mechanics, R. Bowley and M. Sanchez, 2nd Edn., 2007, Oxford Univ. Press
- A treatise on Heat, M. N. Saha and B.N. Srivastava

B.Sc.(H) Physics Sem-VI
Paper: STATISTICAL MECHANICS Lab
Paper Code: BPH-604

No. of Credits: 2
L: 0, P: 4
Lab: 60 Periods

Sessional: 15
External Exam: 35
Total: 50

Use C/C++/Scilab/other numerical simulations for solving the problems based on Statistical Mechanics like

1. Computational analysis of the behavior of a collection of particles in a box that satisfy Newtonian mechanics and interact via the Lennard-Jones potential, varying the total number of particles N and the initial conditions:

a. Study of local number density in the equilibrium state (i) average; (ii) fluctuations.
b. Study of transient behavior of the system (approach to equilibrium)
c. Relationship of large N and the arrow of time.
d. Computation of the velocity distribution of particles for the system and comparison with the Maxwell velocity distribution.
e. Computation and study of mean molecular speed and its dependence on particle mass.
f. Computation of fraction of molecules in an ideal gas having speed near the most probable speed

2. Computation of the partition function Z(□) for examples of systems with a finite number of single particle levels (e.g., 2 level, 3 level, etc.) and a finite number of non-interacting particles N under Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein statistics:

a. Study of how $Z(\beta)$, average energy <E>, energy fluctuation ΔE, C_v, depend upon the temperature, total number of particles N and the spectrum of single particle states.
b. Ratios of occupation numbers of various states for the systems considered above.
c. Computation of physical quantities at large and small temperature T and comparison of various statistics at large and small temperature T.

3. Plot Planck‟s law for Black Body radiation and compare it with Raleigh-Jeans Law at large and small wavelength for a given temperature.

4. Plot Specific Heat of Solids (a) Dulong-Petit law, (b) Einstein distribution function, (c) Debye distribution function for high temperature and low temperature and compare them for these two cases.

5. Plot the following functions with energy at different temperatures

a) Maxwell-Boltzmann distribution
b) Fermi-Dirac distribution
c) Bose-Einstein distribution

6. Plot the distribution of particles w.r.t. energy (dN/dε versus ε) for

a) Relativistic and non-relativistic bosons both at high and low temperature.
b) Relativistic and non-relativistic fermions both at high and low temperature.

Laboratory based Experiments

7. To determine the Planck's constant using LEDs of at least 4 different colours.
8. To verify the Stefan`s law of radiation and to determine Stefan's constant.
9. To determine Boltzmann constant using I-V characteristics of PN junction diode.

Reference Books:

- ElementaryNumericalAnalysis, K.E.Atkinson, 3rd Edn. 2007, WileyIndiaEdition
- Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.
- Introduction to Modern Statistical Mechanics, D.Chandler, Oxford University Press, 1987
- Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.
- Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer
- Statistical and Thermal Physics with computer applications, Harvey Gould and Jan Tobochnik, Princeton University Press, 2010.

Discipline Elective Course in Physics (DECP)
Semester-VI

Select any two papers and corresponding lab (if any)

B.Sc.(H) Physics Sem-VI
Paper: Nuclear and Particle Physics
Paper Code: DECP-601

No. of Credits: 6 | **Sessional: 25**
L: 5, T: 1 | **Theory Exam: 75**
Theory: 75 Lectures | **Total: 100**

Course Objectives: The objective of the course is to impart the understanding of the sub atomic particles and their properties. It will emphasize to gain knowledge about the different nuclear techniques and their applications in different branches of Physics and societal application. The course will focus on the developments of problem based skills.The acquire knowledge can be applied in the areas of nuclear, medical, archeology, geology and other interdisciplinary fields of Physics and Chemistry. It will enhance the special skills required for these fields.

General Properties of Nuclei: Constituents of nucleus and their Intrinsic properties, quantitative facts about mass, radii, charge density, nuclear matter density, binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve, N/Z plot, angular momentum, parity, magnetic moment, electric moments **(10 Lectures)**

Nuclear Models: Liquid drop model approach, semi empirical mass formula and significance of its various terms, condition of nuclear stability, Fermi gas model (degenerate fermion gas, nuclear symmetry potential in Fermi gas), evidence for nuclear shell structure and the basic assumption of shell model **(11 Lectures)**

Radioactivity decay: (a) Alpha decay: basics of α-decay processes, theory of α-emission, Gamow factor, Geiger Nutt all law, α-decay spectroscopy, decay Chains. (b) β -decay: energy kinematics for β -decay, β-spectrum, positron emission, electron capture, neutrino hypothesis. (c) Gamma decay: Gamma rays emission from the excited state of the nucleus & kinematics **(10 Lectures)**

Nuclear Reactions: Types of Reactions, units of related physical quantities, Conservation Laws, kinematics of reactions, Q-value, reaction rate, reaction cross section, Concept of compound and direct Reaction, resonance reaction, Coulomb scattering (Rutherford scattering). **(8 Lectures)**

Interaction of Nuclear Radiation with matter: Energy loss due to ionization (Bethe-Block formula), energy loss of electrons, Cerenkov radiation. Gamma ray interaction through matter(photoelectric effect, Compton scattering, pair production), neutron interaction with matter. **(9 Lectures)**

Detector for Nuclear Radiations: Gas detectors: estimation of electric field, mobility of particle for ionization chamber and GM Counter. Basic principle of Scintillation Detectors and construction of photo-multiplier tube (PMT).Semiconductor Detectors (Si and Ge) for charge particle and photon detection (concept of charge carrier and mobility), neutron detector. **(9 Lectures)**

Particle Accelerators: Accelerator facility available in India: Van-de Graaff generator (Tandem accelerator), Linear accelerator, Cyclotron, Synchrotrons (Principle, construction, working, advantages and disadvantages). . **(7 Lectures)**

Particle physics: Particle interactions (concept of different types of forces); basic features, types of particles and its families. Conservation Laws(energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin, Strangeness), concept of quark model, color quantum number and gluons. **(11 Lectures)**

COURSE OUTCOME

After the successful completion of the course, students would be able to:

- Describe the basic interaction mechanisms for charged particles and electromagnetic radiation and explain the working principles behind detectors and their characteristic properties with respect to energy resolution, efficiency etc.
- Understand the mechanism and kinematics of nuclear reactions.
- Describe the basic features involved in alpha and beta decays and nuclear forces
- Comprehend the fundamentals of elementary particle physics.

Reference Books:

- Nuclear Physics by I. Kapelon.
- Nuclear Physics by W.E. Burcham.
- Nuclear Physics by Enge.
- Atomic Nucleus by Evans.
- Nuclear Physics by S. N. Ghoshal, First edition, S. Chand Publication, 2010.
- Concepts of Nuclear Physics by Bernard L Cohen, Tata McGraw Hill Publication, 1974.
- Introductory Nuclear Physics by Kenneth S, Krane, Wiley-India Publication, 2008
- Radiation detection and measurement, G.F. Knoll, John Wiley & Sons, 2010.
- Introduction to elementary particles by David J Griffiths, Wiley, 2008.

B.Sc.(H) Physics Sem-VI
Paper: Nano Materials and Applications
Paper Code: DECP-602

No. of Credits: 4	**Sessional: 25**
L: 4, T: 0	**Theory Exam: 75**
Theory: 60 Lectures	**Total: 100**

Course Objectives: This course introduces the essence of nano materials, their synthesis, and characterization. On successful completion of the module students should also be able to understand the optical properties and electron transport phenomenon in nanostructures. It also covers few important applications of nano materials used in this technological era.

NANOSCALE SYSTEMS: Density of states (1-D,2-D,3-D). Length scales in physics, Nanostructures: 1D, 2D and 3D nanostructures (nanodots, thin films, nanowires, nanorods)**,** Band structure and density of states of materials at nanoscale, Size Effects in nano systems, Applications of Schrodinger equation- Infinite potential well, potential step, potential box, quantum confinement of carriers in 3D, 2D, 1D nanostructures and its consequences. **(10 Lectures)**

SYNTHESIS OF NANOSTRUCTURE MATERIALS: Top down and Bottom up approach, Ball milling. Gas phase condensation. Vacuum deposition. Physical vapor deposition (PVD): Thermal evaporation, Chemical vapor deposition (CVD).Sol-Gel. Spray pyrolysis. Hydrothermal synthesis. Preparation through colloidal methods. **(8 Lectures)**

CHARACTERIZATION: X-Ray Diffraction. Optical Microscopy. Scanning Electron Microscopy. Transmission Electron Microscopy. Atomic Force Microscopy. Scanning Tunneling Microscopy. **(8 Lectures)**

OPTICAL PROPERTIES: Concept of dielectric constant for nanostructures and charging of nanostructure. Quasi-particles and excitons. Excitons in direct and indirect band gap semiconductor nanocrystals. Quantitative treatment of quasi-particles and excitons, charging effects. Radiative processes: General formalization-absorption, emission and luminescence. Optical properties of heterostrctures and nanostructures. **(14 Lectures)**

ELECTRON TRANSPORT: Carrier transport in nanostrcutures. Coulomb blockade effect, thermionic emission, tunneling and hopping conductivity. Defects and impurities: Deep level and surface defects. **(6 Lectures)**

APPLICATIONS: Applications of nanoparticles, quantum dots, nanowires and thin films for photonic devices (LED, solar cells). CNT based transistors. Nanomaterial Devices: Quantum dots heterostructure lasers, optical switching and optical data storage. Magnetic quantum well; Micro Electromechanical Systems (MEMS), Nano Electromechanical Systems (NEMS). **(14 Lectures)**

COURSE OUTCOME

After the successful completion of the course, students would be able:

- To understand the basics of Nano Science and Nano Technology.
- To apply the Quantum Mechanics for Nanomaterials.
- To learn the various Growth Techniques of Nanomaterials.
- To use the Characterization Tools of Nanomaterials for research applications.

Reference books:

C.P.Poole, Jr. Frank J.Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.)

- S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publishing Company)
- K.K. Chattopadhyay and A. N. Banerjee, Introduction to Nanoscience and Technology (PHI Learning Private Limited).
- Introduction to Nanoelectronics, V.V. Mitin, V.A. Kochelap and M.A. Stroscio, 2011, Cambridge University Press.
- Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).

B.Sc.(H) Physics Sem-IV
Paper: Nano Materials and Applications Lab
Paper Code: DECP-604

No. of Credits: 2 | **Sessional: 15**
L: 0, P: 4 | **External Exam: 35**
Lab: 60 Periods | **Total: 50**

At least 04 experiments from the following:

1. Synthesis of metal nanoparticles by chemical route.
2. Synthesis of semiconductor nanoparticles.
3. Surface Plasmon study of metal nanoparticles by UV-Visible spectrophotometer.
4. Analysis of XRD pattern of nanomaterials and estimation of particle size.
5. To study the effect of size on color of nanomaterials.
6. To prepare composite of CNTs with other materials.
7. Growth of quantum dots by thermal evaporation.
8. Prepare a disc of ceramic of a compound using ball milling, pressing and sintering, and study its XRD.
9. Fabricate a thin film of nanoparticles by spin coating (or chemical route) and study transmittance spectra in UV-Visible region.

10. Prepare a thin film capacitor and measure capacitance as a function of temperature or frequency.
11. Fabricate a PN diode by diffusing Al over the surface of N-type Si and study its V-I characteristic.

Reference Books:

- C.P.Poole, Jr. Frank J.Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.).
- S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publishing Company).
- K.K. Chattopadhyay and A.N. Banerjee, Introduction to Nanoscience & Technology (PHI Learning Private Limited).
- Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).

B.Sc.(H) Physics Sem-VI
Paper: PHYSICS OF DEVICES AND COMMUNICATION
Paper Code: DECP-603

No. of Credits: 4	**Sessional: 25**
L: 4, T: 0	**Theory Exam: 75**
Theory: 60 Lectures	**Total: 100**

Course Objectives: This paper is based on advanced electronics which covers the devices such as UJT, JFET, MOSFET, CMOS etc. Process of IC fabrication is discussed in detail. Digital Data serial and parallel Communication Standards are described along with the understanding of communication systems.

Devices: Characteristic and small signal equivalent circuits of UJT and JFET. Metal-semiconductor Junction. Schottky diode, Metal oxide semiconductor (MOS) device. Ideal MOS and Flat Band voltage. SiO_2-Si based MOS, C-V characteristics of MOS, MOSFET– their frequency limits. Enhancement and Depletion Mode MOSFETS, basic idea of CMOS. ***(15 Lectures)***

Processing of Devices: Basic process flow for IC fabrication. Crystal plane and orientation. Diffusion and implantation of dopants. Passivation. Oxidation Technique for Si. Contacts and metallization technique. Wet etching. Dry etching (RIE). Photolithography. Electron-lithography, Basic idea of SSI, MSI, LSI, VLSI and USI. **(15 Lectures)**

RC Filters: Passive-Low pass and High pass filters, Active (1^{st} order butterworth) –Low Pass, High Pass, Band Pass and band Reject Filters. **(3 Lectures)**

Phase Locked Loop (PLL): Basic Principles, Phase detector (XOR and edge triggered), Voltage Controlled Oscillator (Basics, varactor). Lock and capture. Basic idea of PLL IC (565 or 4046). **(6 Lectures)**

Digital Data Communication Standards:

Serial Communications*: RS232, Handshaking, Implementation of RS232 on PC, Universal Serial Bus (USB), USB standards, Types and elements of USB transfers.* ***(5 Lectures)***

Introduction to communication systems: Block diagram of electronic communication system, Need for modulation. Amplitude modulation. Modulation Index. Analysis of Amplitude Modulated wave. Sideband frequencies in AM wave. CE Amplitude Modulator. Demodulation of AM wave using Diode Detector. Frequency modulation and demodulation, basic idea of Frequency, Phase, Pulse and Digital Modulation including ASK, PSK, FSK. **(15 lectures)**

COURSE OUTCOME

On successful completion of this course, students should be able to:

- *Understand the fabrication and study of advanced electronic device.*
- *Learn the basics of IC fabrication process and various scales of IC fabrication.*
- *Learn various electronic filters and Phase Locked Loop circuits*
- *Understand standards of communication the various communication systems*

Reference Books:

- *Physics of Semiconductor Devices, S.M.Sze and K.K.Ng, 3rd Edition 2008, John Wiley & Sons*
- *Op-Amps & Linear Integrated Circuits, R.A.Gayakwad,4 Ed. 2000, PHI Learning Pvt. Ltd*
- *Electronic Devices and Circuits, A. Mottershead, 1998, PHI Learning Pvt. Ltd*
- Electronic Communication systems, G. Kennedy, 1999, Tata McGraw Hill.
- Introduction to Measurements & Instrumentation, A.K.Ghosh, 3rd Edition, 2009, PHI Learning
- Semiconductor Physics and Devices, D.A. Neamen, 2011, 4th Edition, McGraw Hill
- PC based instrumentation; Concepts and Practice, N. Mathivanan, 2007, Prentice-Hall of India

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B.Sc.(H) Physics Sem-VI

Paper: PHYSICS OF DEVICES AND COMMUNICATION Lab

Paper Code: DECP-605

No. of Credits: 2	**Sessional: 15**
L: 0, P: 4	**External Exam: 35**
Lab: 60 Periods	**Total: 50**

At least 06 experiments each from section-A and section-B:

Section-A:

1. Design and analyze the Clippers and Clampers circuits using junction diode
2. To design a power supply using bridge rectifier and study effect of C-filter.

3. To design the active Low pass and High pass filters of given specification.
4. To design the active filter (wide band pass and band reject) of given specification.
5. To study the output and transfer characteristics of a JFET.
6. To design a common source JFET Amplifier and study its frequency response.
7. To study the output characteristics of a MOSFET.
8. To study the characteristics of a UJT and design a simple Relaxation Oscillator.
9. To design and study an Amplitude Modulator using Transistor.
10. To design PWM, PPM, PAM and Pulse code modulation using ICs.
11. To design an Astable multivibrator of given specifications using transistor.
12. To study a PLL IC (Lock and capture range).
13. To study envelope detector for demodulation of AM signal.
14. Study of ASK and FSK modulator.
15. Glow an LED via USB port of PC.
16. Sense the input voltage at a pin of USB port and subsequently glow the LED connected with another pin of USB port.

Section-B: ***SPICE/MULTISIM simulations for electronic circuits and devices***

1. To verify the Thevenin and Norton Theorems.
2. Design and analyze the series and parallel LCR circuits
3. Design the inverting and non-inverting amplifier using an Op-Amp of given gain
4. Design and Verification of op-amp as integrator and differentiator
5. Design the 1^{st}order active low pass and high pass filters of given cutoff frequency
6. Design a Wein`s Bridge oscillator of given frequency.
7. Design clocked SR and JK Flip-Flop`s using NAND Gates
8. Design 4-bit asynchronous counter using Flip-Flop ICs
9. Design the CE amplifier of a given gain and its frequency response.
10. Design an Astable multivibrator using IC555 of given duty cycle.
11. To study the characteristics of a Thermostat and determine its parameters.
12. Calibrate Semiconductor type temperature sensor (AD590, LM35, LM75) and Resistance Temperature Device (RTD).

Reference Books:

- Basic Electronics: A text lab manual, P.B.Zbar, A.P.Malvino, M.A.Miller,1994, Mc-Graw Hill
- Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
- Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
- OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4^{th} edn., 2000, Prentice Hall.
- Introduction to PSPICE using ORCAD for circuits& Electronics, M.H.Rashid,2003, PHI Learning.
- PC based instrumentation; Concepts & Practice, N.Mathivanan, 2007, Prentice-Hall of India

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B.Sc.(H) Physics Sem-VI
Paper: CLASSICAL DYNAMICS
Paper Code: DECP-606

No. of Credits: 6 **Sessional: 25**
L: 5, T: 1 **Theory Exam: 75**

Theory: 75 Lectures Total: 100

COURSE OBJECTIVE

The course aims to develop an understanding of Lagrangian and Hamiltonian which allow simplified treatments of many problems in classical mechanics. The course aims to provide the foundation for the modern understating of dynamics.

Lagrangian and Hamiltonian formulations
Review of Newtonian Mechanics and its Application to the motion of a charge particle in uniform external electric and magnetic fields- gyroradius and gyrofrequency. Degrees of freedom of a system, Generalized coordinates and velocities. Hamilton's principle, Lagrangian and Lagrange's equations of motion of one-dimensional simple harmonic oscillators, falling body in uniform gravity. Cyclic coordinates. Derivation of Lagrange's equations from Hamilton's principle, Principle of Least Action and its applications, Canonical Transformation; Canonical momenta & Hamiltonian. The physical significance of the Hamiltonian, Hamilton's equations of motion. Comparison of Newtonian, Lagrangian and Hamiltonian mechanics. Applications of Hamiltonian mechanics: Hamiltonian for a simple harmonic oscillator, solution of Hamilton's equations for simple harmonic oscillations (1-D), particle in a central force field – conservation of angular momentum and energy. (25 lecture)

Poisson bracket and theory of small oscillations
Poisson bracket, Poisson theorem, Poisson bracket and canonical transformation, Jacobi identity and its derivation, Lagrange bracket and its properties, the relationship between Poisson and Lagrange brackets and its derivation, the angular momenta and Poisson bracket, Liouville's theorem and its applications. (10 Lectures)
Small Amplitude Oscillations: Minima of potential energy and points of stable equilibrium, Theory of small oscillations: small amplitude oscillations about the minimum, normal modes of longitudinal simple harmonic oscillations (maximum 2 masses connected by 3 springs). Kinetic energy (T) and potential energy (V) in terms of normal co-ordinates. T and V matrices: finding eigen-frequencies and eigen-vectors using these matrices. Normal modes of frequencies and normal coordinates. (15Lectures)

Two-body central force problem and H-J theory
Two body central force problem: Reduction to the equivalent one body problem, the equation of motion and first integrals, classification of orbits, the Virial theorem, the differential equation for the orbit, integrable power law in time in the Kepler's problem, H-J Theory: H-J equation and their solutions. (15 lectures)

Fluid Dynamics: Density ρ and pressure P in a fluid, an element of fluid and its velocity, continuity equation and mass conservation, stream-lined motion, laminar flow, Poiseuille"s equation for flow of a liquid through a pipe. (10 Lectures)

COURSE OUTCOME

On successful completion of this course, students should be able to:

- Understand the Lagrangian and Hamiltonian formalisms so that they can apply these methods to solve real world problems.
- Understand the theory of small oscillations and concept of Poisson bracket.
- Understand the Two-body central force problem and H-J theory.
- Understand the multi-disciplinary topic 'Chaos' which will enable the students to learn non-linear dynamics.

REFERENCE BOOKS:

1. Classical Mechanics, H.Goldstein, C.P. Poole, J.L. Safko, 3 rdEdn. 2002,Pearson Education.
2. Mechanics, L. D. Landau and E. M. Lifshitz, 1976, Pergamon.
3. Classical Mechanics, P.S. Joag, N.C. Rana, 1st Edn., McGraw Hall.
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Department of Physics

Program: M.Sc. Physics

Revised Scheme course index of the year 2016-17 (11th BOS dated 17/7/2017)

Mapping of the courses with the Employability/ Entrepreneurship/ Skill development

S. No.	Course Name	Course code	Employability	Entrepreneurship	Skill Development
1	Mathematical Physics	PHL 101	√		√
2	Classical Mechanics	PHL 102	√		
3	Quantum Mechanics-I	PHL 103	√		
4	Electronic Devices and IC Technology	PHL 104	√	√	√
5	Electronics Laboratory-I	PHP 105	√	√	√
6	Seminar	PHP 106	√	√	√
7	Atomic and Molecular Physics	PHL 201	√		
8	Nuclear and Particle Physics	PHL 202	√		
9	Condensed Matter Physics	PHL 203	√		
10	Electrodynamics and Plasma Physics	PHL 204	√		
11	Physics Laboratory-I	PHP 205	√	√	√
12	Seminar	PHP 206	√	√	√
13	Modern science writing and	AENG-201A	√	√	√
14	Advanced Quantum Mechanics	PHL 301	√		

15	Statistical Mechanics	PHL 302	√	√	√
16	Laser Technology	PHL 303	√		
17	Microprocessor	PHL 304	√		
18	Electronics Lab-II	PHP 305	√	√	√
19	Seminar	PHP 306	√	√	√
20	Physics and our world	OPHL-306A	√	√	√
21	Introduction to Astrophysics and cosmology	OPHL-305A	√	√	√
22	Photonics	PHL401A	√	√	√
23	Radiation Physics	PHL401B	√		
24	Electronic Communication System	PHL 402A	√		
25	Electronic Devices and Communication	PHL 402B	√	√	
26	Nano Science and Technology	PHL 403A	√	√	
27	Computational Physics	PHL 403B	√	√	√
28	Material Science	PHL 404A	√	√	
29	Smart Materials	PHL 404B	√	√	√
30	Dissertation	PHL 405	√	√	√

Department of Physics

Program: B.Sc.(H) Physics

Revised Scheme course index of the year 2016-17 (11th BOS dated 17/7/2017)

Mapping of the courses with the Employability/ Entrepreneurship/ Skill development

S. No.	Name of the new Course	Course Code	Employability	Entrepreneurship	Skill Development
1.	Mathematical Physics-I	BPH 101	√		
2.	Mechanics	BPH 102	√		√
3.	Mathematical Physics-I Lab	BPH 103	√		
4.	Mechanics Lab	BPH 104	√	√	√
5.	English	BENG 101	√	√	√
6.	Calculus	OMTH 101	√	√	√
7.	Electronic circuit & PCB Designing	OELC 101	√	√	√
8.	Introduction to Programming	OCSC 101	√	√	√
9.	Inorganic Chemistry	OCHE 101	√		
10.	Electronic circuit & PCB Designing Lab	OELC 102	√	√	√
11.	Introduction to Programming Lab	OCSC 102 I	√	√	√
12.	Inorganic Chemistry Lab	OCHE 102	√		
13.	MOOC	XXX	√		√
14.	Electricity & Magnetism	BPH 201	√	√	√

15.	Waves & Optics	BPH 202	√	√	√
16.	Electricity & Magnetism Lab	BPH 203	√	√	√
17.	Waves & Optics Lab	BPH 204	√	√	√
18.	Environmental Science	BEVS 101	√	√	√
19.	Linear Algebra	OMTH 201	√		√
20.	Instrumentation	OELC 201	√	√	√
21.	Introduction to Database System	OCSC 201	√	√	√
22.	Physical Chemistry	OCHE 201	√		
23.	Instrumentation Lab	OELC 202	√	√	√
24.	Introduction to Database System Lab	OCSC 202	√	√	√
25.	Physical Chemistry Lab	OCHE 202	√	√	√
26.	MOOC	XXX	√	√	√
27.	Audit Course (French offered by CS department)	AUD-03	√	√	√
28.	Mathematical Physics-II	BPH 301	√	√	√
29.	Thermal Physics	BPH 302	√	√	√
30.	Analog Systems & Applications	BPH 303	√	√	√
31.	Mathematical Physics-II Lab	BPH 304	√	√	√
32.	Thermal Physics Lab	BPH 305	√	√	√
33.	Analog Systems & Applications Lab	BPH 306	√	√	√
34.	Computational Physics Skills	SECP 01	√	√	√
35.	Electrical Circuits & Network Skills	SECP 02	√	√	√
36.	Basic Instrumentation Skills	SECP 03	√	√	√
37.	Computational Physics Skills Lab	SECP 04	√	√	√
38.	Electrical Circuits & Network Skills Lab	SECP 05	√	√	√
39.	Basic Instrumentation Skills Lab	SECP 06	√	√	√

40.	Differential Equations	OMTH 301	√		
41.	Communication Systems	OELC 301	√	√	√
42.	Computer Networks & Internet Technology	OCSC 301	√	√	√
43.	Organic Chemistry	OCHE 301	√	√	√
44.	Communication Systems Lab	OELC 302	√	√	√
45.	Computer Networks & Internet Technology Lab	OCSC 302	√	√	√
46.	Organic Chemistry Lab	OCHE 302	√	√	√
47.	MOOC	XXX	√	√	√
48.	Mathematical Physics-III	BPH 401	√		
49.	Elements of Modern Physics	BPH 402	√		
50.	Digital Systems & Application	BPH 403	√		
51.	Mathematical Physics-III Lab	BPH 404	√	√	√
52.	Elements of Modern Physics Lab	BPH 405	√	√	√
53.	Digital Systems & Applications Lab	BPH 406	√	√	√
54.	Numerical Methods	OMTH 401	√		
55.	Microprocessor & Microcontroller Systems	OELC 401	√		
56.	Information Security	OCSC 401	√		
57.	Spectroscopy	OCHE 401	√	√	√
58.	Microprocessor & Microcontroller Systems Lab	OELC 402	√	√	√
59.	Information Security Lab	OCSC 402	√	√	√
60.	Spectroscopy Lab	OCHE 402	√	√	√
61.	MOOC	XXX	√	√	√
62.	Quantum Mechanics & Applications	BPH 501	√	√	√
63.	Solid State Physics	BPH 502	√		
64.	Quantum Mechanics & Applications Lab	BPH 503	√	√	√

65.	Solid State Physics Lab	BPH 504	√	√	√
66.	Atomic & Molecular Physics	DECP 501	√		
67.	Experimental Techniques	DECP 502	√	√	√
68.	Linear Algebra & Tensor Analysis	DECP 503	√	√	√
69.	Experimental Techniques Lab	DECP 504	√	√	√
70.	Biological & Medical Physics	DECP 505	√	√	√
71.	MOOC	XXX	√	√	√
72.	Electromagnetic Theory	BPH 601	√		
73.	Statistical Mechanics	BPH 602	√		
74.	Electromagnetic Theory Lab	BPH 603	√	√	√
75.	Statistical Mechanics Lab	BPH 604	√	√	√
76.	Nuclear & Particle Physics	DECP 601	√		
77.	Nano Materials & Applications	DECP 602	√	√	√
78.	Physics of Devices & Communication	DECP 603	√	√	√
79.	Nano Materials & Applications Lab	DECP 604	√	√	√
80.	Physics of Devices & Communication Lab	DECP 605	√	√	√
81.	Classical Dynamics	DECP 606	√		

NEW COURSES INTRODUCED

M.Sc Physics

(BOS dated 17th July, 2017)

S.No.	Department	Program Name	Name of the Course	Course Code
1.	Physics	M.Sc. Physics	Mathematical Physics	PHL 101
2.	Physics	M.Sc. Physics	Classical Mechanics	PHL 102
3.	Physics	M.Sc. Physics	Quantum Mechanics-I	PHL 103
4.	Physics	M.Sc. Physics	Electronic Devices and IC Technology	PHL 104
5.	Physics	M.Sc. Physics	Electronics Laboratory-I	PHP 105
6.	Physics	M.Sc. Physics	Seminar	PHP 106
7.	Physics	M.Sc. Physics	Atomic and Molecular Physics	PHL 201
8.	Physics	M.Sc. Physics	Nuclear and Particle Physics	PHL 202
9.	Physics	M.Sc. Physics	Condensed Matter Physics	PHL 203
10.	Physics	M.Sc. Physics	Electrodynamics and Plasma Physics	PHL 204
11.	Physics	M.Sc. Physics	Physics Laboratory-I	PHP 205
12.	Physics	M.Sc. Physics	Seminar	PHP 206
13.	Physics	M.Sc. Physics	Advanced Quantum Mechanics	PHL 301
14.	Physics	M.Sc. Physics	Statistical Mechanics	PHL 302
15.	Physics	M.Sc. Physics	Laser Technology	PHL 303
16.	Physics	M.Sc. Physics	Microprocessor	PHL 304
17.	Physics	M.Sc. Physics	Electronics Lab-II	PHP 305
18.	Physics	M.Sc. Physics	Seminar	PHP 306
19.	Physics	M.Sc. Physics	Physics and our world	OPHL-306A

20.	Physics	M.Sc. Physics	Introduction to Astrophysics and cosmology	OPHL-305A
21.	Physics	M.Sc. Physics	Photonics	PHL401A
22.	Physics	M.Sc. Physics	Radiation Physics	PHL401B
23.	Physics	M.Sc. Physics	Electronic Communication System	PHL 402A
24.	Physics	M.Sc. Physics	Electronic Devices and Communication	PHL 402B
25.	Physics	M.Sc. Physics	Nano Science and Technology	PHL 403A
26.	Physics	M.Sc. Physics	Computational Physics	PHL 403B
27.	Physics	M.Sc. Physics	Material Science	PHL 404A
28.	Physics	M.Sc. Physics	Smart Materials	PHL 404B
29.	Physics	M.Sc. Physics	Dissertation	PHL 405

NEW COURSES INTRODUCED

B.Sc Hon. Physics (BOS dated 17th July, 2017)

Department name	Program name	Name of the new Course	Course Code
Physics	B.Sc Physics Hons.	Mathematical Physics-I	BPH 101
Physics	B.Sc Physics Hons.	Mechanics	BPH 102
Physics	B.Sc Physics Hons.	Mathematical Physics-I Lab	BPH 103
Physics	B.Sc Physics Hons.	Mechanics Lab	BPH 104
Physics	B.Sc Physics Hons.	English	BENG 101
Physics	B.Sc Physics Hons.	Calculus	OMTH 101
Physics	B.Sc Physics Hons.	Electronic circuit & PCB Designing	OELC 101
Physics	B.Sc Physics Hons.	Introduction to Programming	OCSC 101
Physics	B.Sc Physics Hons.	Inorganic Chemistry	OCHE 101
Physics	B.Sc Physics Hons.	Electronic circuit & PCB Designing Lab	OELC 102
Physics	B.Sc Physics Hons.	Introduction to Programming Lab	OCSC 102 l
Physics	B.Sc Physics Hons.	Inorganic Chemistry Lab	OCHE 102
Physics	B.Sc Physics Hons.	MOOC	XXX
Physics	B.Sc Physics Hons.	Electricity & Magnetism	BPH 201
Physics	B.Sc Physics Hons.	Waves & Optics	BPH 202
Physics	B.Sc Physics Hons.	Electricity & Magnetism Lab	BPH 203
Physics	B.Sc Physics Hons.	Waves & Optics Lab	BPH 204
Physics	B.Sc Physics Hons.	Environmental Science	BEVS 101
Physics	B.Sc Physics Hons.	Linear Algebra	OMTH 201
Physics	B.Sc Physics Hons.	Instrumentation	OELC 201
Physics	B.Sc Physics Hons.	Introduction to Database System	OCSC 201
Physics	B.Sc Physics Hons.	Physical Chemistry	OCHE 201
Physics	B.Sc Physics Hons.	Instrumentation Lab	OELC 202
Physics	B.Sc Physics Hons.	Introduction to Database System Lab	OCSC 202
Physics	B.Sc Physics Hons.	Physical Chemistry Lab	OCHE 202
Physics	B.Sc Physics Hons.	MOOC	XXX
Physics	B.Sc Physics Hons.	Audit Course (French offered by CS department)	AUD-03
Physics	B.Sc Physics Hons.	Mathematical Physics-II	BPH 301
Physics	B.Sc Physics Hons.	Thermal Physics	BPH 302

Physics	B.Sc Physics Hons.	Analog Systems & Applications	BPH 303
Physics	B.Sc Physics Hons.	Mathematical Physics-II Lab	BPH 304
Physics	B.Sc Physics Hons.	Thermal Physics Lab	BPH 305
Physics	B.Sc Physics Hons.	Analog Systems & Applications Lab	BPH 306
Physics	B.Sc Physics Hons.	Computational Physics Skills	SECP 01
Physics	B.Sc Physics Hons.	Electrical Circuits & Network Skills	SECP 02
Physics	B.Sc Physics Hons.	Basic Instrumentation Skills	SECP 03
Physics	B.Sc Physics Hons.	Computational Physics Skills Lab	SECP 04
Physics	B.Sc Physics Hons.	Electrical Circuits & Network Skills Lab	SECP 05
Physics	B.Sc Physics Hons.	Basic Instrumentation Skills Lab	SECP 06
Physics	B.Sc Physics Hons.	Differential Equations	OMTH 301
Physics	B.Sc Physics Hons.	Communication Systems	OELC 301
Physics	B.Sc Physics Hons.	Computer Networks & Internet Technology	OCSC 301
Physics	B.Sc Physics Hons.	Organic Chemistry	OCHE 301
Physics	B.Sc Physics Hons.	Communication Systems Lab	OELC 302
Physics	B.Sc Physics Hons.	Computer Networks & Internet Technology Lab	OCSC 302
Physics	B.Sc Physics Hons.	Organic Chemistry Lab	OCHE 302
Physics	B.Sc Physics Hons.	MOOC	XXX
Physics	B.Sc Physics Hons.	Mathematical Physics-III	BPH 401
Physics	B.Sc Physics Hons.	Elements of Modern Physics	BPH 402
Physics	B.Sc Physics Hons.	Digital Systems & Application	BPH 403
Physics	B.Sc Physics Hons.	Mathematical Physics-III Lab	BPH 404
Physics	B.Sc Physics Hons.	Elements of Modern Physics Lab	BPH 405
Physics	B.Sc Physics Hons.	Digital Systems & Applications Lab	BPH 406
Physics	B.Sc Physics Hons.	Computational Physics Skills	SECP 01
Physics	B.Sc Physics Hons.	Electrical Circuits & Network Skills	SECP 02
Physics	B.Sc Physics Hons.	Basic Instrumentation Skills	SECP 03
Physics	B.Sc Physics Hons.	Computational Physics Skills Lab	SECP 04
Physics	B.Sc Physics Hons.	Electrical Circuits & Network Skills Lab	SECP 05
Physics	B.Sc Physics Hons.	Basic Instrumentation Skills Lab	SECP 06
Physics	B.Sc Physics Hons.	Numerical Methods	OMTH 401
Physics	B.Sc Physics Hons.	Microprocessor & Microcontroller Systems	OELC 401
Physics	B.Sc Physics Hons.	Information Security	OCSC 401
Physics	B.Sc Physics Hons.	Spectroscopy	OCHE 401
Physics	B.Sc Physics Hons.	Microprocessor & Microcontroller Systems Lab	OELC 402

Physics	B.Sc Physics Hons.	Information Security Lab	OCSC 402
Physics	B.Sc Physics Hons.	Spectroscopy Lab	OCHE 402
Physics	B.Sc Physics Hons.	MOOC	XXX
Physics	B.Sc Physics Hons.	Quantum Mechanics & Applications	BPH 501
Physics	B.Sc Physics Hons.	Solid State Physics	BPH 502
Physics	B.Sc Physics Hons.	Quantum Mechanics & Applications Lab	BPH 503
Physics	B.Sc Physics Hons.	Solid State Physics Lab	BPH 504
Physics	B.Sc Physics Hons.	Atomic & Molecular Physic	DECP 501
Physics	B.Sc Physics Hons.	Experimental Techniques	DECP 502
Physics	B.Sc Physics Hons.	Linear Algebra & Tensor Analysis	DECP 503
Physics	B.Sc Physics Hons.	Experimental Techniques Lab	DECP 504
Physics	B.Sc Physics Hons.	Biological & Medical Physics	DECP 505
Physics	B.Sc Physics Hons.	MOOC	XXX
Physics	B.Sc Physics Hons.	Electromagnetic Theory	BPH 601
Physics	B.Sc Physics Hons.	Statistical Mechanics	BPH 602
Physics	B.Sc Physics Hons.	Electromagnetic Theory Lab	BPH 603
Physics	B.Sc Physics Hons.	Statistical Mechanics Lab	BPH 604
Physics	B.Sc Physics Hons.	Nuclear & Particle Physics	DECP 601
Physics	B.Sc Physics Hons.	Nano Materials & Applications	DECP 602
Physics	B.Sc Physics Hons.	Physics of Devices & Communication	DECP 603
Physics	B.Sc Physics Hons.	Nano Materials & Applications Lab	DECP 604
Physics	B.Sc Physics Hons.	Physics of Devices & Communication Lab	DECP 605
Physics	B.Sc Physics Hons.	Classical Dynamics	DECP 606

FACULTY OF HUMANITIES AND SCIENCES

DEPARTMENT OF PHYSICS

M.Sc. (Physics)

ACADEMIC SESSION 2017-2018

YMCA UNIVERSITY OF SCIENCE AND TECHNOLOGY

YMCA UNIVERSITY OF SCIENCE AND TECHNOLOGY

VISION

YMCA University of Science and Technology aspires to be a nationally and internationally acclaimed leader in technical and higher education in all spheres which transforms the life of students through integration of teaching, research and character building.

MISSION

- To contribute to the development of science and technology by synthesizing teaching, research and creative activities.
- To provide an enviable research environment and state-of-the art technological exposure to its
  Scholars.
- To develop human potential to its fullest extent and make them emerge as world class leaders in their professions and enthuse them towards their social responsibilities

HUMANITIES AND SCIENCES DEPARTMENT

VISION

A department that can effectively harness its multidisciplinary strengths to create an academically stimulating atmosphere; evolving into a well-integrated system that synergizes the efforts of its competent faculty towards imparting intellectual confidence that aids comprehension and complements the spirit of inquiry.

MISSION

- To create well-rounded individuals ready to comprehend scientific and technical challenges offered in the area of specialization.
- To counsel the students so that the roadmap becomes clearer to them and they have the zest to turn the blueprint of their careers into a material reality.
- To encourage critical thinking and develop their research acumen by aiding the nascent spirit for scientific exploration.
- Help them take economic, social, legal and political considerations when visualizing the role of technology in improving quality of life.
- To infuse intellectual audacity that makes them take bold initiatives to venture into alternative methods and modes to achieve technological breakthroughs.

M.Sc. Physics

The M.Sc. program in Physics aims to provide students with a sound knowledge of the principles of Physics which form a thorough basis for careers in Physics and related fields. It also aims to enable students to develop insights into the techniques used in current fields and allow an in-depth experience of a particular specialized research area. In addition, the M.Sc Program is meant to develop professional skills in students that play a meaningful role in industrial and academic life and give students the experience of teamwork, a chance to develop presentation skills and learn to work to deadlines. The M.Sc. program includes a number of lecture courses and laboratory courses both relevant to the discipline and forward-looking with respect to recent developments and state-of-the-art achievements.

PROGRAM OBJECTIVE

The objective of the program is

- To prepare students for careers in University teaching and research.
- To develop thorough and in-depth knowledge of various courses in Physics such as Electronics, Quantum Mechanics, Nuclear Physics, and Condensed matter Physics, Laser, Nanotechnology, etc.
- To inculcate strong student competencies in Physics and its applications in a technology-rich, interactive environment.
- To develop strong student skills in research, analysis and interpretation of complex information.
- To prepare the students to successfully compete for employment in Research labs and teaching and to offer a wide range of experience in research methods, data analysis to meet industrial needs.

PROGRAM OUTCOMES

After completion of the program, the students will:

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

YMCA UNIVERSITY OF SCIENCE AND TECHNOLOGY, FARIDABAD
DEPARTMENT OF HUMANITIES AND SCIENCES

STRUCTURE AND SYLLABI OF M.SC. PHYSICS (4 SEMESTER COURSE)

SEMESTER I

Subject Code	Title	L	T	P	Internal Assessment	End-semester Examination	Total	Credits	Category Code
PHL 101	Mathematical Physics	4	0	0	25	75	100	4	DCC
PHL 102	Classical Mechanics	4	0	0	25	75	100	4	DCC
PHL 103	Quantum Mechanics-I	4	0	0	25	75	100	4	DCC
PHL 104	Electronic Devices and IC Technology	4	0	0	25	75	100	4	DCC
PHP 105	Electronics Laboratory-I	0	0	20	30	70	100	8	DCC
PHP 106	Seminar	2	0	0	50		50	0	DCC
XXX	MOOC**								MOOC
Total Marks							**550**	**24**	

* DCC – Discipline Core Course; MOOC – Massive Open Online Course
**The students have to pass at least one mandatory MOOC course with 4-6 credits (12-16 weeks) from the list given list on the Swayam portal or the list given by the Department/ University from 1st semester to 3rd semester as notified by the University. (Instructions to students overleaf)
L – Lecture; P - Practical; Tutorial

Instructions to the students regarding MOOC

1. Two types of courses will be circulated: branch specific and general courses from the website https://swayam.gov.in in the month of June and November every year for the forthcoming semester.
2. The department coordinators will be the course coordinators of their respective departments.
3. Every student has to pass a selected MOOC course within the duration ass specified below:

Programme	Duration
B. Tech.	Sem. I to Sem. VII
M.Sc./M.Tech./M.A./MBA	Sem. I to Sem. III
B.Sc./MCA	Sem. I to Sem. V

The passing of a MOOC course is mandatory for the fulfillment of the award of the degree of concerned programme.

4. A student has to register for the course for which he is interested and eligible which is approved by the department with the help of course coordinator of the concerned department.
5. A student may register in the MOOC course of any programme. However, a UG student will register only in UG MOOC courses and a PG student will register in only PG MOOC courses.
6. The students must read all the instructions for the selected course on the website, get updated with all key dates of the concerned course and must inform his/her progress to their course coordinator.
7. The student has to pass the exam (online or pen-paper mode as the case may be) with at least 40% marks.
8. The students should note that there will be a weightage of Assessment/quiz etc. and final examination appropriately as mentioned in the instructions for a particular course.
9. A student must claim the credits earned in the MOOC course in his/her marksheet in the examination branch by forwarding his/her application through course coordinator and chairperson.

SEMESTER II

Subject Code	Title	L	T	P	Internal Assessment	End-semester Examination	Total	Credits	Category Code
PHL 201	Atomic and Molecular Physics	4	0	0	25	75	100	4	DCC
PHL 202	Nuclear and Particle Physics	4	0	0	25	75	100	4	DCC
PHL 203	Condensed Matter Physics	4	0	0	25	75	100	4	DCC
PHL 204	Electrodynamics and Plasma Physics	4	0	0	25	75	100	4	DCC
PHP 205	Physics Laboratory-I	0	0	20	30	70	100	8	DCC
PHP 206	Seminar	2	0	0	50		50	0	DCC
XXX	Audit Course*	2	0	0	25	75	100	0	AUD
Total Marks							**650**	**24**	

- DCC – Discipline Core Course; AUD-Audit Course; L – Lecture; P – Practical: T-Tutorial
- *provided by the Department/ University.

SEMESTER III

Subject Code	Title	L	T	P	Internal Assessment	End-semester Examination	Total	Credits	Category Code
PHL 301	Advanced Quantum Mechanics	4	0	0	25	75	100	4	DCC
PHL 302	Statistical Mechanics	4	0	0	25	75	100	4	DCC
PHL 303	Laser Technology	4	0	0	25	75	100	4	DCC
PHL 304	Microprocessor	4	0	0	25	75	100	4	DCC
PHP 305	Electronics Lab-II	0	0	20	30	70	100	8	DCC
PHP 306	Seminar	2	0		50		50	0	DCC
XXX	Open Elective*	3	0	0	25	75	100	3	OEC
Total Marks							**650**	**27**	

- DCC – Discipline Core Course; OEC – Open Elective Course; L – Lecture; P – Practical
- *The department offers two open elective courses which can be taken by students of other departments.

SEMESTER IV

Subject Code	Title	L	T	P	Internal Assessment	End-semester Examination	Total	Credits	Category Code
PHL401A	Photonics	4	0	0	25	75	100	4	DEC
PHL401B	Radiation Physics								
PHL 402A	Electronic Communication System	4	0	0	25	75	100	4	DEC
PHL 402B	Electronic Devices and Communication								
PHL 403A	Nano Science and Technology	4	0	0	25	75	100	4	DEC
PHL 403B	Computational Physics								
PHL 404A	Material Science	4	0	0	25	75	100	4	DEC
PHL 404B	Smart Materials								
PHL 405	Dissertation	2	0	0	30	70	100	8	DCC
Total Marks							**500**	**24**	

- DCC – Discipline Core Course; DEC – Discipline Elective Course; L – Lecture; P - Practical
- Students have to select one DEC paper from each group or the course offered by the Department.
- Elective Courses can be offered subject to availability of requisite resources/ faculty in the University/Department.

Grading Scheme

*Percentage	Grade	Grade Points	Category
95-100	O	10	Outstanding
85-95	A+	9	Excellent
75-85	A	8	Very Good
65-75	B+	7	Good
55-65	B	6	Above average
45-55	C	5	Average
40-45	P	4	Pass
<	F	0	Fail
	AD	0	Absent

***Lower limit included, upper limit excluded**

The multiplication factor for CGPA is 10

1. Automatic Rounding
2. Average difference between actual percentage and CGPA percentage ± 2.5%
3. Worst case difference between actual percentage and CGPA percentage ± 5% if somebody in all the 8 semesters in all the exams (around 75 in numbers) consistently scores at the bottom of the range, say 55 of 55-65 which is a very remote possibility.

M.Sc. PHYSICS I SEM

PHL 101

SUBJECT NAME: MATHEMATICAL PHYSICS

NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

This course has been developed to introduce students to some topics of mathematical Physics which are directly relevant in different papers of Physics course. It includes functions of a complex variable and calculus, special functions, elements of group theory, Integral Transforms.

Unit I: Theory of functions of a Complex variable (12hrs)

Function of a Complex variable, Exponential functions, Logarithmic functions, Analyticity and Cauchy condition, Cauchy-Riemann equations, necessary and sufficient conditions for a function to be analytic, Harmonic functions, Cauchy's Integral Theorem, Cauchy's Integral formula, Taylor's Series and Laurent's series and expansion, Zeroes and Singular Points, Multi valued functions, Residues, Cauchy's Residue Theorem, Jordon's Lemma, Evaluation of real definite integrals.

Unit II: Special Functions (12 hrs.)

Bessel Functions: Bessel functions of the first kind $J_n(x)$, Generating function, Recurrence relations, Expansion of $J_n(x)$ when n is half an odd integer, Integral representation; Legendre Polynomials $P_n(x)$: Generating function, Recurrence relations and special properties, Rodrigues' formula, Orthogonality of $P_n(x)$; Associated Legendre polynomials and their orthogonality, Hermite and Laguerre Polynomials: generating function & recurrence relations only.

Unit III: Matrices and Group Theory (12 hrs.)

Matrices: Orthogonal, Unitary and Hermitian Matrices with examples, Independent elements of orthogonal and unitary matrices of order 2, Matrix diagonalization, eigenvalues and eigenvectors; Fundamentals of Group theory: Definition of a group and illustrative examples, Group multiplication table, rearrangement theorem, cyclic groups.

Unit IV: Integral Transforms (12hrs)

Fourier Integral theorem, Fourier Sine, Cosine and Complex transforms with examples, Properties of Fourier transform, Fourier transforms of Derivatives, Parseval's theorem,

Convolution theorem, Fourier transform of Integrals.
Laplace Transforms, Transforms of some Elementary Functions, Properties of Laplace transform, Transform of Derivatives, Transform of Integrals, Convolution theorem and its applications, Inverse Laplace Transform by partial fractions method

COURSE OUTCOMES

After completion of the course, students will have would be able

- To solve real definite integrals in theoretical Physics.
- To use special functions for solving Quantum Mechanical Problems.
- To use matrices for solving linear algebraic equations and to use group theory for understanding of crystallography.
- To use integral transforms for analysis of wave mechanics.

REFERENCE BOOKS:

1. Arfken: Numerical methods for Physicists
3. Ghatak: Mathematical Physics
4. H.K. Dass: Mathematical Physics
5. M. R. Spiegel: Schaum's Outlines Complex Variables
6. M. Tinkam: Group theory and Quantum Mechanics
7. B. Baumslag, B. Chandler: Schaum's Outlines Group Theory

M.Sc. PHYSICS I SEM

PHL 102

SUBJECT NAME: CLASSICAL MECHANICS

NO OF CREDITS:4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

The course aims to develop an understanding of Lagrangian and Hamiltonian which allow simplified treatments of many problems in classical mechanics. The course aims to provide the foundation for the modern understating of dynamics.

Unit I: Lagrangian and Hamiltonian formulations (12 hrs.)
Hamilton's principle, Derivation of Lagrange's equations from Hamilton's principle, Principle of Least Action and its applications, Canonical Transformation; The Hamiltonian Formalism: Canonical formalism, Hamiltonian equations of motion, The physical significance of the Hamiltonian, Cyclic coordinates, Routhian procedure and equations,

Unit II: Poisson bracket and theory of small oscillations (12 hrs.)
Poisson bracket, Poisson theorem, Poisson bracket and canonical transformation, Jacobi identity and its derivation, Lagrange bracket and its properties, the relationship between Poisson and Lagrange brackets and its derivation, the angular momenta and Poisson bracket, Liouville's theorem and its applications; Theory of small oscillations: Formulation of the problem, Eigen value equation and the principle axis transformation, frequencies of free vibrations and normal coordinates, free vibrations of a linear triatomic molecule, beyond small oscillations; the damped driven pendulum.

Unit III: Two-body central force problem and H-J theory (12 hrs.)
Two body central force problem: Reduction to the equivalent one body problem, the equation of motion and first integrals, classification of orbits, the Virial theorem, the differential equation for the orbit, integrable power law in time in the Kepler's problem, H-J Theory: H-J equation and their solutions.

Unit IV: Introductory non-linear dynamics (12 hrs.)
Classical Chaos: Periodic motion, phase portraits for conservative systems, attractors, classification and stability of equilibrium points, stability analysis of cubic anharmonic oscillator and undamped pendulum, chaotic trajectories and Liapunov exponent, Poincare Map, Henon-Hiels Hamiltonian, driven-damped harmonic oscillator

COURSE OUTCOME

On successful completion of this course, students should be able to:

- Understand the Lagrangian and Hamiltonian formalisms so that they can apply these methods to solve real world problems.
- Understand the theory of small oscillations and concept of Poisson bracket.
- Understand the Two-body central force problem and H-J theory.
- Understand the multi-disciplinary topic 'Chaos' which will enable the students to learn non-linear dynamics.

REFERENCE BOOKS:

1. Classical Mechanics (3rd ed., 2002) by H. Goldstein, C. Poole and J. Safko
2. Classical Mechanics of particles and rigid bodies by K. C. Gupta
3. Chaos and Integrability in nonlinear dynamics: An introduction (1989) by Michael Tabor
4. Nonlinear dynamics: Integrability, Chaos and patterns (2003) by M. Lakshmanan and S. Rajaseka

M.Sc. PHYSICS I SEM

PHL 103

SUBJECT NAME: QUANTUM MECHANICS

NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

This course aims at providing an elementary introduction to the basic principles of (non-relativistic) Quantum Mechanics, and its wave-mechanical and matrix-mechanics formulations. This course would enable students to comprehend the basic structure of Quantum Mechanics and to use it in different branches of Physics like Atomic and Molecular Physics, Nuclear Physics, Condensed Matter Physics etc.

UNIT-I: General formalism of Quantum Mechanics (12hrs)

Overview of Linear Vector Space, Basis, operators, Interpretative postulates of quantum mechanics, Dirac Notations of Bra and Ket, Matrix Representation of Observables and States, Determination of Eigen values and Eigen functions of Observables, orthogonality, completeness. Hilbert space representation, Matrix Representations, Change of Representation and Unitary Transformation, Co-ordinate and Momentum Representations, Equations of Motion in Schrodinger and Heisenberg Pictures.

UNIT-II: Theory of Angular Momentum (12hrs)
Orbital angular momentum operator L, Cartesian and spherical polar co-ordinate representation, Commutation Rules for Angular Momentum, Eigen values and Eigen functions of L^2 and L_z General angular momentum operator J Eigen values and Eigen functions of J^2 and J_z Matrix Representation of Angular Momentum Operator, Spin angular momentum, Wavefunction including spin(Spinor), spin one half: spin Pauli Spin Matrices.

UNIT-III: Scattering (12hrs)
Differential and Total Cross-Sections, Laboratory and center of mass frame, Theory of Partial Wave and Calculation of Phase Shifts in Simple Cases, Integral Form of Scattering Equation, Born Approximation, Its Validity and Simple Applications.

UNIT-IV: Perturbation Theory (12hrs)

Perturbation Theory of Non-degenerate Systems with first order correction, Application to Normal He Atom, Zeeman Effect, Perturbation Theory for Degenerate Systems, First order correction, Stark Effect in H-Atom, Time Dependent Perturbation Theory, Fermi's Golden Rule and Example of Harmonic Perturbations.

COURSE OUTCOME

On successful completion of this course, students should be able to:

- Understand the general formalism of Quantum Mechanics.
- Understand the theory of Angular Momentum and its application in quantum mechanics.
- Understand the theory of scattering and calculation of Phase Shifts in Simple Cases.
- Apply the perturbation theory for time independent and time dependent cases.

REFERENCE BOOKS:

1. Ghatak & Lokanathan: Quantum Mechanics
2. Schiff: Quantum Mechanics
3. Dirac: Principles of Quantum Mechanics
4. Sakurai: Modern Quantum Mechanics
5. Das and Melissinos: Quantum Mechanics - A Modern Introduction

M.Sc. PHYSICS I SEM

PHL 104
SUBJECT NAME: ELECTRONIC DEVICES AND IC TECHNOLOGY
NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

This course is designed to understand the basics of transistors and their applications as amplifiers. Designing of simple circuits like amplifiers (inverting and non inverting), comparators, adders, integrator and differentiator using op-amps will be discussed.

The second part of the course will give an introduction to digital electronics in which the different building blocks in digital electronics using logic gates and implementation of simple logic function using basic universal gates will be covered.

Unit I: Semiconductor Devices and Fabrication of ICs (12 hrs)

Metal/Semiconductor Contact, MOS Junction (Accumulation, Depletion and Inversion), Interface States and Their Effects, Fabrication of ICs, monolithic Integrated Circuit Technology, planar process, Fabrication of Bipolar Transistor, Resistor, capacitor, FET.

Unit II: Bipolar junction transistor and Field effect transistor (12 hrs)

PNP and NPN transistors, basic transistor action, emitter efficiency, base transport factor, current gain, input and output characteristics of CB, CE and CC configurations and amplifiers, Construction of JFET, MOSFET, Idea of channel formation, pinch off and saturation voltage, current voltage output characteristics.

Unit III: Op-Amp (IC-741) and 555 Timer (12 hrs)

DC coupled amplifiers, common mode rejection ratio, Block Diagram of Op-Amp, Input offset voltage, Input bias current, Slew Rate, Frequency Response and Compensation, Feedback in amplifiers, Inverting and non inverting amplifiers, Linear application of op amp: summing, difference, Integration, differentiator, Non-Linear application of op amp: Comparator, Zero crossing detector, Schmitt trigger

555 Timer: 555 Timer – Description and block diagram - Monostable operation, Astable operation

Unit IV: Digital Circuits and Systems (12 hrs)

Binary Adders, full adder and half adder, serial and parallel adders, binary subtractor, Digital comparator, BCD to decimal Decoder, multiplexer, Demultiplexer, Memory Concept, RAM, ROM, PROM, EPROM, EEPROM, Flip-Flops: SR, JK, Master Slave, D Type, T Type, Shift register, Asynchronous counter, Up-Down counter, Divided by N counter.

COURSE OUTCOMES

On successful completion of this course, students should be able to:

- Understand various semiconductor devices the fabrication of ICs
- Understand the working and characteristics of BJT and FET.
- Understand the working and applications of Op-Amp (IC-741) and 555 Timer.
- Understand the Digital Circuits and Systems

REFERENCE BOOKS:

1. Millman and Halkias: Integrated Electronics
2. Gayakwad: OP-AMPS and Linear Integrated Circuits
3. Jacob Millman and Arvin Grabel: Microelectronics

MSc PHYSICS I SEM

PHP 105

ELECTRONICS LAB I

NO OF CREDITS: 8

		SESSIONAL:	30
L	P	THEORY EXAM:	70
0	16	TOTAL:	100

COURSE OBJECTIVE

This course is designed to provide students with fundamental concepts of Electronic Circuits for lab experience such as study of operation of Oscillators and Waveform generators like multivibrators and Schmitt trigger. This lab will also give students the preview of the various applications of op-amp and flip flops.

Students assigned the electronic laboratory work will perform at least 8 experiments of the following

1. To design full adder and full subtractor and verify its truth table using logic gates.
2. To design JK Flip flop and realize up down counter using it.
3. To study negative feedback in op amp (summing/difference.
4. To construct an astable multivibrator using transistor and to determine the frequency of oscillation.
5. To design basic comparator and Zero crossing detector using 741 op amp.
6. Application of op-amp as an integrator/differentiator amplifier.
7. To design an astable and monostable multivibrator using 555 timer.
8. To study the common emitter transistor using npn transistor.
9. To study Zener diode as a voltage regulator.
10. To design 4 bit shift register using JK Flip flop.
11. To design multiplexer/demultiplexer.

COURSE OUTCOMES

• Verify the working of diodes, transistors and their applications.
• Build a common emitter/base/collector amplifier and measure its voltage gain.
• Understand the use of CRO.

• Explore the operation and advantages of operational amplifiers.
• Learn to design different types of filters and apply the same to oscillators and amplifiers.
• Exploring the circuitry which converts an analog signal to digital signal.

M.Sc. PHYSICS II SEM
PHL 201
SUBJECT NAME: ATOMIC AND MOLECULAR PHYSICS
NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

To understand the fundamentals of atomic and molecular physics. To provide a coherent and concise coverage of traditional atomic and molecular physics.

UNIT-1: Atomic Physics (12hrs)

Fine structure of hydrogen atoms-mass correction, Spin orbit term, Darwin term, Intensity of fine structure lines, ground state of two electron atoms-perturbation theory and variation method. Many electron atoms- LS and jj coupling schemes, Lande interval rule. Terms for equivalent & non-equivalent electron atom. Space Quantization: stern Gerlach experiment, normal & anomalous Zeeman effect, Stark effect, Paschen-Back effect; Intensities of spectral line: General selection rule, Hyperfine Structure, Isotope Shifts and Nuclear Size Effects.

UNIT-II: Molecular Structure(12hrs)

Born-Oppenheimer separation for diatomic molecules, rotation, vibration and electronic structure of diatomic molecules. Description of Molecular Orbital and Electronic Configuration of Diatomic Molecules: H_2, H_2^+. Co-relation diagram for hetero-nuclear molecules.

UNIT-III: Molecular Spectra(12hrs)

Rotation, Vibration-rotation and electronic spectra of diatomic molecules. The Franck Condon Principle. Raman Spectroscopy: Introduction, pure rotational Raman Spectra, vibrational Raman spectra, Nuclear spin and intensity alternation in Raman spectra, Isotope effect and Raman spectrometer. Dissociation and pre dissociation, Dissociation energy, Rotational fine structure of electronic bands.

UNIT-IV: Resonance Spectroscopy(12hrs)

NMR: Basic principles- classical and quantum description-Bloch Equation-spin-spin and spin-lattice relaxation times-chemical shift and coupling constant- experimental methods-single and double coil methods; ESR: Basic principles, ESR Spectrometer-nuclear interaction and hyperfine structure-relaxation effects-g factor.

COURSE OUTCOME

On successful completion of this course, students should be able to:

- Understand the fundamental aspects of atomic and molecular physics.
- Understand the molecular structure.
- Carry out experimental and theoretical studies on atoms and molecules, with focus on the structure and dynamics of atoms and molecules, and
- Understand resonance spectroscopy; NMR, ESR.

REFERENCE BOOKS:

1 Concepts of Modern Physics by Arthur Beiser (McGraw-Hill Book Company, 1987).
2 Atomic spectra & atomic structure, Gerhard Hertzberg: Dover publication, New York.
3 Molecular structure & spectroscopy, G. Aruldhas; Prentice – Hall of India, New Delhi.
4 Fundamentals of molecular spectroscopy, Colin N. Banwell & Elaine M. McCash, Tata McGraw –Hill publishing company limited.
5 Introduction to Atomic spectra by H.E. White
6 Spectra of diatomic molecules by Gerhard Herzberg
7 Principles of fluorescence spectroscopy by Joseph R. Lakowicz

M.Sc. PHYSICS II SEM
PHL 202
SUBJECT NAME: NUCLEAR AND PARTICLE PHYSICS
NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

The course aims to provide students with an understanding of basic radiation interaction and detection techniques for nuclear physics, radioactive decays, nuclear reactions and elementary particle physics.

Unit I: Detectors and Accelerators (12hrs)

Interaction of Nuclear Radiations with matter; Interaction of charged Particles and of Gamma Rays with matter, Stopping power of Heavy charged particles Range and Straggling, Absorption of Gamma- Rays, the P.E effect , Compton Effect and Pair production, Nuclear detectors for high Energy Physics, Spark Chamber Cerenkov Detector, GM counter, Scintillation detector

Unit II: Nuclear Reaction (12hrs)

Liquid drop model, Shell model, Types of Nuclear Reactions, Nuclear Reaction Kinematics, Nuclear transmutations, Transmutations by alpha particles, protons, neutrons, deuterons, etc, Nuclear Cross section, Expression for Scattering and Nuclear Cross-section, Reaction Mechanism- Direct and Compound nuclear reactions, Compound Nucleus theory, Energy levels of nuclei, Continuum Theory of Nuclear Reaction, Resonance cross- sections, Breit-Wigner Dispersion Formula.

Unit III: Radioactive decay and Nuclear forces (12hrs)

Alpha particles, their charge to mass ratio, range, energy, Gamow's Theory of Alpha-Decay, Fermi's Theory of Beta-Decay, Curie's Plots; the neutrino, its detection and properties, Gamma Radiation, measurement of Gamma-Ray energy, Deuteron problem; neutron-proton and proton-proton scattering at low energies , Partial wave Analysis.

Unit IV: Particle Physics (12hrs)

Units of high energy physics, Classification of particles-fermions and bosons, Particles and antiparticles, Strange particles, Basic idea of different fundamental types of interactions with suitable examples, Quarks flavors and their quantum numbers, Quarks as constituents of Hadrons

COURSE OUTCOME

After the successful completion of the course, students would be able to:

- Describe the basic interaction mechanisms for charged particles and electromagnetic radiation and explain the working principles behind detectors and their characteristic properties with respect to energy resolution, efficiency etc.
- Understand the mechanism and kinematics of nuclear reactions.
- Describe the basic features involved in alpha and beta decays and nuclear forces
- Comprehend the fundamentals of elementary particle physics.

REFERENCE BOOKS:

1. **Preston and Bhaduri: Nuclear structure**
2. **Pal: Nuclear structure**
3. **Wong: Introductory Nuclear Physics**
4. **R.M Singru: Introduction to experimental Nuclear Physics**
5. **Tayal: Nuclear Physics**

M.Sc. PHYSICS II SEM
PHL 203
SUBJECT NAME: CONDENSED MATTER PHYSICS
NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

Our objective is to train students in the field of condensed matter physics and materials science. The concepts of lattice, crystal structure, reciprocal lattice, phonon, Fermi surface, Brillouin zone, metal and semiconductor theory and properties will be taught.

The use of more sophisticated models of electron behavior in a periodic potential, such as the tight binding model, to explain the electronic structure of materials will be done qualitatively and quantitatively.

Unit I: Symmetry and Reciprocal Lattice

crystal symmetry elements, Miller indices, Direct lattice type, fundamental type of direct lattices i.e. 2 dimensional and 3 dimensional lattice, reciprocal lattice, reciprocal lattice (sc, bcc, fcc) Bragg's law in direct and reciprocal lattice, crystal structure factor (bcc, fcc), atomic form factor, Scattering factors, Intensity of diffraction maxima, extinction due to lattice centering.

Unit II: Lattice Vibration

The concept of lattice modes of vibration, elastic vibrations of continuous media, vibration of one dimensional mono-atomic and diatomic linear lattice, particle displacement in two branches, wavelength limit of acoustic phonons, concept of phonons, inelastic scattering of photons and phonons, inelastic scattering of X rays by phonons, inelastic scattering of neutrons by phonons, electron phonon interaction, polarons, electron-electron interaction

Unit III: Electronic Properties of Solids

Electrons in periodic potential, Kronig Penny model for band theory, brillouin zone, reduced zone, effective mass, physical interpretation of effective mass, distinction between metals, semiconductors and insulators, density of state function, density of electrons in conduction band, density of holes in valence bands, Donor and acceptor impurities in n-type and p-type semiconductors, Metal-Semiconductor junctions.

UNIT IV: Methods To Evaluate The Energy Levels

Tightly bound electron approximation method, application to simple cubic lattice, Wigner-Seitz approximation, pseudo potential method, Fermi surface, experimental methods in Fermi surface studies: quantization of orbits in magnetic field, de Hass van Alphen effect, Fermi surface of copper, Cyclotron resonance, Quantum Hall effect, direct absorption process, indirect absorption process.

COURSE OUTCOMES

- Recognize common crystal structures and describe their symmetries. Describe diffraction using the reciprocal lattice. Determine the structure of crystalline materials by x-ray diffraction
- Use models to calculate dispersion relations for acoustical and optical phonons.
- Perform band structure calculations for simple systems in the weak potential- and in the Linear Combination of Atomic Orbitals approximations. Describe the formation of band-structure in crystals.
- Describe the experimental methods to understand the Fermi surface in crystals.

REFERENCE BOOKS:

1. Introduction to Solid State Physics : Charles Kittel
2. Solid State Physics : A J Dekker

3 Solid State Physics: S.O. Pillai

M.Sc. PHYSICS II SEM

PHL 204

SUBJECT NAME: ELECTRODYNAMICS AND PLASMA PHYSICS

NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVES

To have a deep understanding of electrodynamics using scientific methods and to apply the concepts of electromagnetic theory for various communication systems.

Unit I: Introduction to Electrodynamics (12 hrs.)

Energy stored in an electric and magnetic fields. Continuity Equation, Displacement Current, Maxwell's equations, power flow in an electromagnetic field and pointing theorem. Electromagnetic waves in a homogeneous medium-solution for free space conditions. Uniform plane waves, the wave equations for a conducting medium, Sinusoidal time variations, Maxwell's equations using phasor notation. Wave propagation in a loss less medium, wave propagation in a conducting medium, wave propagation in a good dielectric.

Unit II:Electromagnetic Waves (12hrs)

Reflection & Refraction of Plane waves:- Boundary Conditions, Laws of reflection and refraction of plane waves, Reflection by a perfect dielectric – normal and oblique incidence, Fresnel relations, Brewster's angle, Reflection by a perfect conductor – normal incidence, Power loss in a plane conductor.

Polarization:- Linear, elliptical and circular Polarization, Direction cosines.

Dispersion and Scattering:- Radiative reaction force, scattering and absorption of radiation, Thompson scattering and Rayleigh Scattering, Polarization of Scattered Light, Normal and anomalous dispersion, Dispersion relation of EM waves in Solids, Liquids and gases.

Unit III: Electromagnetic fields and Radiation by Moving Charges (12 hrs.)

Electromagnetic scalar and vector potentials, Maxwell's equations in terms of scalar and vector potentials, Non uniqueness of Electromagnetic potentials and concept of Gauge. Lorentz gauge and coulomb gauge.

Moving point charges, Retarded potentials, Lienard-Wiechart potentials for a point charge, the fields of moving charge particles, Total power radiated by a point charge: Larmor's formula and its relativistic generalization.

Unit IV: Plasma Physics & Waveguides(12 hrs.)

Elementary Concepts: Plasma as fourth state of matter, Various kinds of Plasma, Quasineutrality of plasma, Debye Shielding, Plasma Parameters, Plasma production and heating of the plasma, Plasma Oscillations and plasma frequency expression, Fluid equations, electron plasma wave, ion acoustic wave, Magnetoplasma and Plasma Confinement, plasma instabilities, applications of Plasma.

Wave guides:- TE, TM and TEM waves, TE and TM modes in rectangular wave guides, concept of cut off frequency.

COURSE OUTCOMES

Students who have completed this course should

- Have a deep understanding of electromagnetic theory and propagation of EM waves though various media.
- Be able to understand the phenomena of reflection, refraction, polarization and dispersion of EM waves.
- Understand the fields and potentials due to moving charges.
- Be able to understand the concepts of Plasma Physics and waveguides.

REFERENCE BOOKS:

1.Classical Electrodynamics by J.D. Jackson.
2. Introduction to Electrodynamics by D. J. Griffiths.
3. Introduction to Plasma Physics by Francis F. Chen.
4. Introduction to Electrodynamics by A. Z. Capri and P. V. Panat.

M.Sc. PHYSICS II SEM

PHP 205

SUBJECT NAME: **PHYSICS LAB II**

		SESSIONAL:	30
L	P	THEORY EXAM:	70
0	16	TOTAL:	100

Students assigned the general laboratory work will perform at least 8 experiments of the following:

COURSE OBJECTIVE

To develop basic experimental knowledge in physics by extending knowledge and processes used by physics which produce new and exciting technologies in everyday use.

1. To determine the Ionization potential of Lithium.
2. Determination of range of Beta-rays from Ra and Cs using GM Counter.
3. Measurement of resistivity of a semiconductor by four-probe method at different temperature and determination of band gap.
4. Determination of Lande's factor of DPPH using ESR spectrometer.
5. Determination of Hall coefficient of a given semiconductor and estimation of charge carrier concentration.
6. Study of Faraday effect using He-Ne Laser. To determine the angle of rotation as a function of the mean flux density using different colour filters. To calculate the corresponding Verdet′s constant in each case and to evaluate Verdet′s constant as a function of the wavelength.
7. Determination of dislocation energy of Iodine molecule by photography the absorption bands of I_2 in the visible region.
8. Determination of the wavelengths of the most intense spectral lines of He and Hg (two electron System).
9. Determination of e/m of electron by normal Zeeman Effect using Febry Perot Etalon.
10. To verify the Compton scattering formula, derived from the quantum theory of electromagnetic radiation, and as a consequence, the mass of the electron will be determined.
11. To understand how electric and magnetic fields impact an electron beam and experimentally determine the electron charge-to-mass ratio.
12. To determine the hysteresis loss by C.R.O, use a hysteresis curve to measure the power loss of an iron core transformer • for comparison, measure the loss for a ferrite core transformer • estimate the Curie point for ferrite.

Note: Addition and deletion in the list of experiments may be made from time to time by the department.

COURSE OUTCOME

On successful completion of this course, students should be able to

- Utilize scientific method for formal investigation of physical laws.
- Demonstrate competency with experimental methods that are used to discover and verify the concepts related to content and research knowledge.

M.Sc. PHYSICS III SEM
PHL 301

SUBJECT NAME: ADVANCED QUANTUM MECHANICS

NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

The aim of the course is to introduce students to the basics of relativistic quantum mechanics, classical and quantum field theories. The course is planned as a continuation of Quantum Mechanics course taught in first semester.

Unit I: Solution of Schrodinger Equation for Three Dimensional Problems: (12hrs)

The Three Dimensional Harmonic Oscillator in both Cartesian and Spherical Polar Coordinates, Eigenvalues Eigenfunctions and the Degeneracy of the States; Solution of the Hydrogen Atom Problem, The Eigenvalues Eigen functions and the Degeneracy.

Unit II: Relativistic Quantum Mechanics (12hrs)

Klein Gordon Equation, Klein Gordon equation in Electromagnetic field, Dirac's relativistic equation, Electromagnetic potentials: Magnetic moment of the electron, Negative energy solution, Anti-particles.

Unit III: Identical Particles (12hrs)

Introduction, Symmetrical and Antisymmetric wave function, Symmetrization postulate, Particle Exchange operator, Distinguishability of Identical particles, The Pauli's Exclusion principle, Slater determinant, Central Field Approximation, Hartee's Self consistent field approximation.

Unit IV: Field Quantization(12hrs)

The Classical approach to Field theory, Relativistic Lagrangian and Hamiltonian of a charged particle in an electromagnetic field, The Lagrangian and Hamiltonian formulation, Creation, Annihilation and Number operators, Field and its canonical quantization, Quantization of Dirac Field. Hydrogen atom.

COURSE OUTCOME

After the successful completion of the course, students would be able to:

- Understand the foundations of Quantum mechanics
- Acquire working knowledge of relativistic quantum mechanics.

- Understand the concept of identical particles
- Understand Field quantization and concepts

REFERENCE BOOKS:

1. Khanna: Quantum Mechanics
2. Lahiri and Pal: A first book on Quantum Mechanics
3. Griener: Quantum Mechanics
4. Liboff: Introductory Quantum Mechanics

M.Sc. PHYSICS III SEM

PHL 302

SUBJECT NAME: STATISTICAL MECHANICS
NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

This course is intended to provide a firm foundation to students in a very fundamental subject of Statistical Mechanics. It aims to derive the macroscopic behavior of a system in terms of mechanics of its microscopic constituents, and finds application in almost all branches of Physics. To demonstrate practical importance of the course, some simple applications from different branches of Physics are included.

Unit I: Ensembles: Review (12hrs)

Micro-canonical Ensemble, Entropy in Statistical Mechanics, Connection between Statistical and Thermo dynamical quantities, perfect gas in micro-canonical Ensemble Partition function, Partition function and Thermo dynamical quantities, Gibb's Paradox, Canonical Ensemble , Perfect Monotonic Gas in Canonical Ensemble, Grand Canonical Ensemble, Perfect Gas in GCE

Unit II: Quantum Statistical Mechanics (12hrs)

Basic concepts, Postulates of Quantum Mechanics, Symmetric and Anti Symmetric Wave functions, Statistical Weight or a Priori Probability, Density Matrix, Bose Einstein Statistics, Fermi Dirac Statistics, Maxwell Boltzmann Statistics, Evaluation of constants α and β, Bose Einstein Gas and Bose Einstein (BE) Condensation, Maxwell Boltzmann distribution as a limiting case of BE distribution, Degeneracy and BE condensation, Correlation to Fermi Dirac gas.

Unit III: Statistical Mechanics of Interacting System (12hrs)

Theory of Imperfect Gases, Cluster Expansion of a Classical Gas, Mayer Cluster Expansion, Determination of Virial Coefficients, Equation of state, Linear Harmonic and Anharmonic oscillators..

Unit IV: Low Temperature Physics (12hrs)

Production and Measurement of Low temperature, Helium I and Helium II, Some Peculiar properties of Helium II and their Explanation, Landau theory, London's Theory, Ising Model .

COURSE OUTCOME

Students who have completed this course should:

- Have a deep understanding of Ensemble theory.
- Be able to solve Quantum statistical mechanics problems for simple non –interacting system,
- Have a basic understanding of Statistical mechanics of interacting system
- Be able to understand low temperature physics.

REFERENCE BOOKS:

1. **Patharia: Statistical Mechanics**
2. **Huang: Statistical Mechanics**
3. **Ma: Statistical Mechanics**
4. **Landau and Lifshitz: Statistical Mechanics**

M.Sc. PHYSICS III SEM

PHY-303

SUBJECT NAME: LASER TECHNOLOGY

NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

To understand the basic laser fundamentals, unique properties of the laser, types of practical lasers and laser safety and industrial applications of high and low power lasers. Apart from this, topics of current research interest will be also discussed, such as laser cooling and trapping which plays an important role in the realization of Bose-Einstein condensate in atomic vapors.

Unit-I: Basic Principle and Different Lasers (12hrs)

Laser characteristics : Spontaneous and Stimulated Emission, Absorption, Laser Idea, Pumping Schemes, Properties of Laser Beams : Monochromaticity, Coherence, Directionality, Brightness, radiative transition and Amplified Spontaneous Emission, Non-radiative delay, Resonator, rate equations, Methods of Q-switching

Unit-II: Types of Lasers (12hrs)

Principle and Working of CO_2 Laser , Semiconductor Laser. Homo-structure and Hetero-structure P–N Junction Lasers, Nd-YAG Lasers. Principle of Excimer Laser. Principle and Working of Dye Laser. Free Electron Laser. Photo detector p-n diode, nano laser, Ultrafast laser

Unit-III: Non-Linear Processes (12hrs)

Propagation of Electromagnetic Waves in Nonlinear Medium, Self-Focusing, Phase Matching Condition, Raman Scattering: Stimulated Raman Scattering, Hyper Raman Scattering and CARS, Two Photon Absorptions process.

Unit IV: Novel Applications of Laser (12hrs)

Cooling and Trapping of Atoms, Principles of Doppler and Polarization Gradient Cooling, Qualitative Description of Ion Traps, Optical Traps and Magneto-Optical Traps and Bose Condensation.

COURSE OUTCOME

On successful completion of this course, students should be able to:

- Understand the basic principles of laser system
- Know about the working of various laser including gas, liquid and solid state laser
- Understand the non linear processes in which self focusing, phase matching conditions and raman scattering.
- Know cooling and trapping of atoms along with Bose Condensation.

REFERENCE BOOKS:

1. Demtroder: Laser Spectroscopy and Instrumentation
2. Svelto: Principles of Lasers
3. Ghosh: Laser Cooling and Trapping
4. Sengupta: Frontiers in Atomic, Molecular and Optical Physics.

5. Laud: Laser and nonlinear optics

M.Sc. PHYSICS IV SEM

PHY 304
SUBJECT NAME: MICROPROCESSOR

NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

The objective of this course is to familiarize the students with the architecture and the instruction set of an Intel microprocessor 8086. Assembly language programming will be studied as well as the design of various types of digital and analog interfaces. The student will be able to draw a block diagram of a simple computer consisting of a processor, RAM and ROM memory, ports, and the buses that interconnect these components

UNIT I : Introduction to Microprocessor and 8085 Microprocessor (12hrs)

Microprocessor evolution and types, Architecture, Microprocessor and computer languages: machine language, assembly language and high level language, advantage of assembly language, introduction to 8085 microprocessor, internal architecture, Timing and control unit, registers, data and address bus, status flags, pin configuration, Applications of microprocessors.

UNIT II: 8086 Microprocessor (12hrs)

Introduction to 8086, overview of 8086 microprocessor family, 8086 internal Architecture, stack segment register, stack pointer registers, Accessing data in memory, Introduction to programming for 8086 microprocessor, program development steps, constructing the machine code for 8086 instructions, assembly language program development tools, writing simple program for use with an assembler.

UNIT III: 8086Microprocessor System Hardware (12hrs)

Basic 8086 microcomputer system, pin diagram of 8086, minimum and maximum modes, timing diagram, physical memory organization, addressing memory (RAM, ROM) and ports in microcomputer system, 8086 addressing and addressing decoding, programmable parallel ports and handshake input and output, 8255 A internal block diagram, 8255 A operational modes and initialization, pin diagram of 8255 A

UNIT IV: Digital interfacing (12hrs)

Interfacing to keyboards, alphanumeric displays, interfacing microcomputer ports to high power devices Direct Memory Access (DMA) Data Transfer, Timing diagram of 8237 DMA, brief introduction of microcontroller, difference between microprocessor and microcontroller, pin diagram of 8051 microcontroller.

COURSE OUTCOME

- Understanding the basics of microprocessor and 8085 microprocessor.
- Understanding of the Intel 8086 architecture. Knowledge of the 8086 instruction set and ability to utilize it in programming.
- Learning addressing modes (Immediate, direct, extended, indexed modes). Understanding of the Intel 8086 real mode memory addressing.
- Ability to interface various devices to the microprocessor. Introduction to the microcontroller.

REFERENCE BOOKS:

1. Liu and Gibson: Microprocessor System the 8086 / 8088 Family
2. Hall: Microprocessor and Interfacing
3. Ram: Fundamentals of Microprocessor

MSc III SEMESTER LAB

ELECTRONICS LAB II

PHP 305

		SESSIONAL:	25
L	P	THEORY EXAM:	75
0	16	TOTAL:	100

Students assigned the general laboratory work will perform at least 8 experiments of the following:

COURSE OBJECTIVE

- To provide practical knowledge and develop skill in digital system & microprocessor,
- To provide the practical knowledge of microwave test bench &measurement,
- To provide the knowledge of modulation and demodulation.

SYLLABUS

1. Microwave Characteristics and Measurements.
2. Nonlinear Applications of Op Amp.
3. PLL Characteristics and its Applications.
4. PAM, PWM and PPM Modulation and Demodulation
5. PCM / Delta Modulation and Demodulation.
6. Fibre Optic Communication.
7. Arithmetic Operations Using Microprocessors 8085 / 8086.
8. D/A Converter Interfacing and Frequency / Temperature Measurement with Microprocessor 8085 / 8086.
9. A/D Converter Interfacing and AC/DC Voltage / Current Measurement Using Microprocessor 8085/8086.
10. PPI 8251 Interfacing with Microprocessor for Serial Communication.
11. Assembly Language Program on PC

Note: Addition and deletion in the list of experiments may be made from time to time by the department.

COURSE OUTCOME

- The students will understand the operation and design of digital system.
- The students will able to work on microprocessor, interfacing & programming on pc.

M.Sc. PHYSICS IV SEM

PHL 401A

SUBJECT NAME: PHOTONICS

NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

The course aims to provide students with an understanding of basic optics, optical fibre communication system and devices, optical fibre sensors and fibre fabrication.

Unit I : Optical Fiber Waveguides (12hrs)

Introduction; Principle of Light Transmission in a fiber, Ray theory transmission, Electromagnetic mode theory for optical propagation, Modes in a planar waveguide, Fiber index profiles, multi-mode step-index fibers, multi-mode graded index fibers, single mode step index fibers.

Unit II: Input / Output Devices (12hrs)

Optical sources, the Laser, Basic concepts, semiconductor laser, light emitting diode, the semiconductor junction diode; Optical detectors, principle, important parameters of ODs, photodiodes, photo conductors, PIN photodiode

Unit III: Transmission characteristics of Optical Fibers (12hrs)

Attenuation in optical fibers, absorption losses, fiber bend losses, linear scattering losses, Rayleigh scattering, non-scattering losses, Stimulated Brillouin Scattering (SBS), Stimulated Raman Scattering (SRS), Material dispersion, inter-modal dispersion.

Unit IV : Fiber technology Characterization and Optical Communication (12hrs)

Fiber materials, glass fibers, active glass fibers, plastic optical fibers (POF), Photonic crystal fibers (PCF), Index guiding PCF, Photonic band gap fibers, Fiber fabrication, Outside Vapor-phase oxidation, Vapor-phase Axial deposition. Principle components of an O.F.C.S, optical sources, optical detectors, optical amplifier, fiber couplers or directional couplers, Elementary idea of Optical Fiber Sensors

COURSE OUTCOME

After the successful completion of the course, students would be able to

- Understand optical fiber wavegudes and their applications.
- Comprehend the use of input/output devices in optical fiber communication.
- Understand the transmission charscteristics of optical fibers.
- Develop a clear understanding of optical fibre communication, fiber technology and Sensor devices.

REFERENCE BOOKS:

1. Ghatak and Thyagrajan: Introduction to Fiber Optics
2. Keiser: Optical Fiber Communication
3. Gowar: Optical Communication System
4. Sapna Katiyar: Optical Fiber Communication
5. Senior: Optical Fiber Communication

M.Sc. PHYSICS IV SEM

SUBJECT NAME: RADIATION PHYSICS (PHL 401B)

NO OF CREDITS: 4

L	P		
		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

The course aims to provide students with a deep understanding of radiation physics. The course also aims to make students familiar with thermal neutrons, nuclear spectrometry and analytical techniques.

Unit I: Thermal Neutrons (12hrs)

Energy distribution of thermal neutrons, Effective cross-section of thermal neutrons, lowing down of reactor neutrons, Angular and energy distribution, Transport mean free path and scattering cross-section, Average logarithmic energy decrement, slowing down power and moderating ratio, Slowing down density, slowing down time, Resonance escape probability

UnitII: Nuclear Chain Reaction and Nuclear diffusion (12hrs)

Neutron cycle and multiplication factor, Neutron leakage and critical size, Nuclear reactor and their classification. Thermal neutron diffusion, Neutron diffusion equation, Thermal diffusion length, Exponential pile, Diffusion length of a fuel moderator mixture, Fast neutron diffusion and Fermi age equation, Correction of neutron capture**.**

Unit III: Nuclear Spectrometry and Applications (12hrs)

Analysis of nuclear spectrometric data, Measurements of nuclear energy levels, spins parities, moments, internal conversion coefficients, Angular correlation, Perturbed angular correlation, Measurement of g factors and hyperfine fields.

Unit IV: Analytical Techniques (12hrs)

Principles, Instrumentation and spectrum analysis of XRF, PIXE and neutron activation analysis techniques. Theory, instrumentation and applications of electron spin resonance (ESR) spectroscopy. Experimental techniques and applications of Mossbauer Effect, Rutherford backscattering.

COURSE OUTCOME:

After the successful completion of the course, the students would be able to :

- Understand the properties of thermal neutrons.
- Understand nuclear chain reactions and nuclear diffusion.
- Understand nuclear spectro-photometry and applications
- Use analytical techniques such as XRF, PIXE etc.

REFERENCE BOOKS:

1. Singru RM: Introduction to experimental nuclear physics
2. Glasstone and Edlund: The elements of nuclear reactor theory.
3. Murray: Introduction to nuclear engineering
4. Krane K.S: Introductory Nuclear Physics

M.Sc. PHYSICS IV SEM

PHL 402A

SUBJECT NAME: ELECTRONIC COMMUNICATION SYSTEM

NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

The course aims to develop an understanding of microwaves, waveguide and klystron. The course aims to develop knowledge of Radar functions and its application. It also aims develop an understanding of communication system and signals.

Unit I: Introduction to communication system (12hrs)
Information transmitter, channel noise, receiver, need for modulation bandwidth requirements, noise and its types, representation of AM, frequency spectrum, power relations in AM wave, techniques for generation of AM, AM transmitter, AM receiver types, single and multi-super hetrodyne receivers, communication receivers

Unit II: Frequency modulation and radar system (12hrs)
Description of FM systems, mathematical representation, comparison of wide band and narrow band FM, FM generation techniques, FM demodulators, FM receivers
Radar systems: Basics principals, pulsed radar systems, moving targets indication, radar beacons, CW Doppler radar, frequency modulated CW radar, phased array radars, planar array, radar

Unit III: Pulse communication (12hrs)
Information theory, pulse modulation, types of pulse modulation, pulse amplitude modulation (PAM), pulse width modulation (PWM), pulse position modulation (PPM) and pulse code modulation (PCM), PCM transmission system, telegraphy.

Unit IV: Broadband communication system (12hrs)
Frequency division multiplex (FDM), Time division multiplex (TDM), coaxial cables, fiber optics links, microwave links, tropospheric scatter links, submarine cables, satellite communication systems, elements of long distance telephony

COURSE OUTCOME

Students who have completed this course should:

- Gain knowledge and understanding of communication systems.
- Have basic knowledge of frequency modulation and radar system.

- Have knowledge of pulse communication and its applications
- Comprehend broadband communications.

REFERENCE BOOKS:

1. Haykin: Communication System
2. Kennedy: Electronics and communication system
3. Kulkarni: Microwave and radar engineering
4. Roddy and Coolen: Electronics Communication

M.Sc. PHYSICS IV SEM

PHL 402B
SUBJECT NAME: ELECTRONIC DEVICES AND COMMUNICATION

NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE:

The aim of the course is to provide students with a thorough knowledge of Semiconductor devices, Microwave devices and memory devices.

Unit I: Semiconductor Devices (12hrs)

Review of p-n junction, metal semiconductor and metal oxide semiconductor junctions, review of JFET, MESFET and MOSFET- their frequency limits. Noise: Signal to noise ratio (SNR) and enhancement of SNR in instrumentation and communication

Unit II: Microwave Devices (12hrs)

Tunnel diode, transfer electron devices (Gunn diode), Avalanche transit time devices (Reed, Impact diodes, parametric devices), vacuum tube devices, reflex klystron and magnetron.

Unit III: Memory Devices(12hrs)

Volatile static and D-RAM, CMOS and NMOS, non volatile-NMOS, ferroelectric semiconductors, optical memories, magnetic memories, charge coupled devices (CCD), Piezoelectric, pyroelectric and magnetic devices, SAW and integrated devices.

Unit IV: Communication (12hrs)

Basics of Modulation and demodulations, Difference between AM, FM and PM, mathematical and graphical analysis of AM signals, power relation, generation of AM waves, Block diagram of digital communication system, different communication techniques, advantage of digital communication, radar block diagram, basic radar range equation.

COURSE OUTCOME:

After the successful completion of the course, students would be able to:

- Understand the construction and working semiconductor devices, p-n junction, MOSFET etc
- Have an in-depth knowledge of microwave devices.
- Understand the basic principle of memory devices.
- Understand the principle of communication and its various techniques.

REFERENCE BOOKS:

1. Haykin: Communication System
2. Kennedy: Electronics and communication system
3. Kulkarni: Microwave and radar engineering
4. Roddy and Coolen: Electronics Communication

M.Sc. PHYSICS IV SEM

CODE: PHL -403A
SUBJECT NAME: NANO SCIENCE AND TECHNOLOGY

NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

Introduction to the underlying principles and applications of the emerging field of nanotechnology and nanoscience along with able to practically synthesize and characterize the nano material. Moreover this course introduces tools and principles which are relevant at the nanoscale dimension. Current and future nanotechnology applications in engineering, materials, physics etc will be discussed.

UNIT-1: Introduction to Nano Science and Nano Technology (12hrs)

Introduction to nanomaterials, Band Structure, Density of states of nanoscale Size, dimensionality effects, size effects, properties of materials & nanomaterials; Era of nanostructres of carbon: Fullerenes, Graphene and Carbon Nano Tubes, BN Nano Tubes.

UNIT-II: Quantum Mechanics for Nanoscience (12hrs)

Quantum Well Structures: electron confinement in infinitely deep square well, confinement in one and two dimensional well, idea of a quantum well structure, quantum dots, quantum wires. Resonant tunneling quantized energy levels, reflection and transmission by a potential step and by a rectangular barrier, Quantum confinement effect in nanomaterials.

UNIT-III: Growth Techniques of Nanomaterials (12hrs)

Top-Down & Bottom-Up, Lithographic techniques and its limitations, Non lithographic techniques, Fabrication of Nanomaterials by different Methods: -Plasma Arc discharge, Sputtering, pulse laser deposition, Ball Milling, Molecular beam epitaxy, Evaporation, Chemical vapour deposition, Electro deposition, Sol gel Method.

UNIT-IV: Characterization Tools of Nanomaterials and Applications (12hrs)

Electron Microscopy: SEM and TEM, Scanning Probe Microscopy (SPM), TEM, Scanning Tunneling Microscopy (STM), Atomic force Microscopy (AFM). UV-visible, Deep Level Transmission(DLT) and Raman spectroscopy.

COURSE OUTCOME

After the successful completion of the course, students would be able:

- To understand the basics of Nano Science and Nano Technology.
- To apply the Quantum Mechanics for Nanomaterials.
- To learn the various Growth Techniques of Nanomaterials.
- To use the Characterization Tools of Nanomaterials for research applications.

REFERENCE BOOKS:

1. Poole and Owens: Introduction to Nanotechnology
2. Nanoscale materials -Liz Marzan and Kamat
3. Nanoscience & Technology: Novel structure and phenomea by Ping Sheng (Editor)
4. Nano Engineering in Science & Technology: An introduction to the world of nano design by Michael Rieth.
5. Nanotubes and Nanowires- CNR Rao and A Govindaraj RCS Publishing
6. Nalva (editor): Handbook of Nanostructured Materials and Nanotechnology

M.Sc. PHYSICS IV SEM

PHL - 403 B

SUBJECT NAME: **COMPUTATIONAL PHYSICS**

NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE:

This course aims to develop in students computations skills to handle problems in theoretical and experimental physics. The student would be able to handle problems in differentiation and integration, solution of differential equations and simulate specific physical problems.

Unit I: Differentiation and Integration (12 hrs.)

Differentiation: Taylor series method, Numerical differentiation using Newton's forward difference formula, Backward difference formula, Stirling's formula, Cubic splines method; Integration: Trapezoidal rule, Simpson's 1/3 rule, Gaussian Quadrature, Legendre–Gauss Quadrature, Numerical double integration, Numerical integration of singular integrals.

Unit II: Solution of Differential Equations (12 hrs.)

Numerical solution of ordinary differential equations: Taylor's series method, Euler's method, Forth-order Runge Kutta method, Cubic splines method; Second order differential equations:

Initial and boundary value problems, Numeric solution of Radial Schrodinger equation for Hydrogen atom using Forth-order Runge-Kutta method(when eigenvalue is given), Numerical Solutions of Partial Differential Equations Using Finite Difference Method.

Unit III: Random Numbers and Chaos (12 hrs.)

Random numbers: Random number generators, Mid-square methods, Multiplicative congruential method, mixed multiplicative congruential methods, modeling radioactive decay. Hit and miss Monte-Carlo methods, Monte-Carlo calculation of π, Monte-Carlo evaluation of integration, Evaluation of multidimensional integrals; Chaotic dynamics: Some definitions, The simple pendulum, Potential energy of a dynamical system. Portraits in phase space: Undamped motion, Damped motion, Driven and damped oscillator.

Unit IV: Simulation of selected physics problems (12 hrs.)

Algorithms to simulate interference and diffraction of light, Simulation of charging and discharging of a capacitor, current in LR and LCR circuits, Computer models of LR and LCR circuits driven by sine and square functions, Computer model of Rutherford scattering experiment, Simulation of electron orbit in H_2 ion.

COURSE OUTCOME:

After the successful completion of the course, the student would be able to:

- Learn about the various integration and diffractions methods.
- Deduce Numerical solution of ordinary differential equations.
- Generate the random numbers using various techniques.
- Simulate selected physics problems using various computational methods.

REFERENCE BOOKS:

1. F B Hildebrand: Introduction to Numerical Analysis, Tata McGraw Hill, New Delhi.
2. R C Desai: Fortran Programming and Numerical methods, Tata McGraw Hill, New Delhi.
3. Suresh Chandra: Computer Applications in Physics, Narosa Publishing House.
4. William H. Press, Saul A Teukolsky, William T Vellerling and Brain P. Flannery: Numerical Recipes in Fortran, Cambridge University Press.
5. M L De Jong: Introduction to Computation Physics, Addison-Wesley publishing company.

M.Sc. PHYSICS IV SEM

PHL 404A

SUBJECT NAME: MATERIAL SCIENCE

NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

Expose the students to different classes of materials, Metals, Ceramics, Polymers, Composites, their properties, structures, imperfections, Defects and Diffusion present in them. Manipulate atomic/micro structural processes to create desired structure & processes.

Unit I: Imperfections in Solids (12 hrs.)

Point Defects: vacancy, substitutional, interstitial, Frenkel and Schottky defects, equilibrium concentration of Frenkel and Schottky defects**;** Line Defects: slip planes and slip directions, edge and screw dislocations, Burger's vector, cross-slip, glide and climb, jogs, dislocation energy, super & partial dislocations, dislocation multiplication, Frank Read sources; Planar Defects: Free energy, grain boundaries, twin interfaces, and stacking fault; volume Defects: precipitates and dispersants

Unit II: Mechanical Properties (12 hrs.)

Stress Strain Curve; Stress: tensor and concentration; stress in two dimension, Elastic Deformation: Isotropic and Anisotropic; Anelastic and Viscous deformation; Plastic Deformation: True stress and Strain, Critically resolved shear stress; Slip theory: Perfect and real crystal; Strengthening Mechanisms: work hardening, recovery, recrystallization, strengthening from grain boundaries, strain aging, solid solution strengthening; Creep & its Mechanism, Fracture: Introduction.

Unit III: Metallurgy (12 hrs.)

Solid Solutions and Intermediate Phases: phase rule, unitary & binary phase diagrams, Lever rule, Hume-Rothery rule; Free Energy and Equilibrium Phase Diagrams: complete solid miscibility, partial solid miscibility-eutectic, peritectic and eutectoid reactions, eutectaid mixture; Diffusion: Fick's law, Kirkendall Effects, Atomic model of diffusion, Nernst-Einstein relation Phase transformation: Nucleation, Growth and Overall Transformation Kinetics, and Process: Precipitation, Solidification, Crystallization, and Glass transition

UNIT IV: Materials Characterization (12 hrs.)

Ion Implantation: introduction, ion implantation process, depth profile, radiation damage and energy losses: Nuclear and electronic; Ion Beam characterization Technique: Rutherford Backscattering Spectrometry (RBS): principle, kinematics of elastic collision, shape of the backscattering spectrum, depth profiles and concentration analysis, Elastic Recoil Detection Analysis (ERDA): basic principle, kinematics, concentration analysis, depth profiling, depth resolution, Secondary Ion Mass Spectroscopy (SIMS): basic principle, working, yield of secondary ions and applications.

COURSE OUTCOME

After the successful completion of the course, the student would be able to:

- Understand structure and defects based properties relationship for Crystal Metals & Ceramics materials
- Gain knowledge of behavior of metal, ceramic and polymers under mechanical forces
- Select materials for design and construction
- Understand Material characterization through Ion beam techniques

REFERENCE BOOKS:

1. Material Science by J. C. Anderson, K. D. Leaver, J. M. Alexander and R. D. Rawlings
2. Mechanical Metallurgy by G. E. Dieter
3. Materials Science and Engineering by V. Raghavan
4. Fundamentals of Surface and Thin Film Analysis by L.C. Feldman and J.W. Mayer

M.Sc. PHYSICS IV SEM

PHL 404B

SUBJECT NAME: SMART MATERIALS

NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

The goal of this course is to expose the students to the general area of smart materials like composites, polymers, dielectrics and ceramics with an emphasis on novel materials and emerging applications. Students will learn the potentials of smart sensors and actuators, the challenges associated with their uses.

Unit I: Composite materials (12hrs)
Agglomerated composites, cermets, laminates, Reinforced composite materials, classification of reinforced composite materials, flakes composite, whisker reinforced composites, hybrid composites, sandwich composites, fiber reinforced glass and glass ceramic composites, polymer concrete, fiber reinforced concrete (pRC), MMC and wood composites, advantages and limitations of composites, fibers, forms of reinforcing fibers, mechanic of composite laminates, generalized Hook's law and elastic constants

Unit II: Ceramic materials (12hrs)
Refractories, silica and silicates, glasses, glass-forming constituents, types of glasses, perovskite structure of mixed oxides, lime, cement, cement concrete, reinforced cement concrete (RCC), pre-stressed concrete, rocks and stones, clay and clay based ceramics, chemically bonded ceramics.

Unit III: Materials and Alloys (12hrs)
Alloys, Alloys in different applications, heat resisting alloys, Cryogenic alloys, bearing metals (Baaits), Metals and alloys for nuclear industry, common ferrous and non ferrous alloys, monomers of polymer, Degree of polymerization, Mechanism of polymersation, additives in polymers, strengthening mechanism of polymers, deformation of polymers.

Unit IV Dielectric materials
Classification of dielectrics, polarization, basic properties of dielectrics, electrical susceptibility, power loss, electric breakdown, effect of temperature and frequency on permittivity, insulating materials, ferro-electrics, piezo-electrics, electrets, pyroelectrics and elecrostriction

COURSE OUTCOME

After the successful completion of the course, the student would be able to:

- Understand the structure of composite materials and the areas of application.
- Differentiate between different types of ceramics, their synthesis and different constituents
- Learn about the various kind of materials and their alloys for different industrial applications.
- Classify the various kinds of dielectrics and their applications in different devices.

REFERENCE BOOKS:

1. Material Science by J. C. Anderson, K. D. Leaver, J. M. Alexander and R. D. Rawlings

2. Mechanical Metallurgy by G. E. Dieter
3. Material Science and Engineering: K M Gupta

AUDIT COURSE
COURSE CODE: APHL-203A

SUBJECT NAME: RENEWABLE ENERGY RESOURSES

		SESSIONAL:	25
L	P	THEORY EXAM:	75
3	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE: This course will enable students learn and understand the importance of alternate energy resources. They will also study the fundamentals of renewable energy resources.

SYLLABUS

UNIT I: PRINCIPLES OF SOLAR RADIATION:

Limitation of conventional energy sources, need and growth of alternative energy sources, basic scheme and application of direct energy conservation, Role and potential of new and renewable source, the solar energy option, Environmental impact of solar power, physics of the sun, the solar constant, extraterrestrial and terrestrial solar radiation, solar radiation on titled surface, instruments for measuring solar radiation and sun shine, solar radiation data.

UNIT II: SOLAR ENERGY COLLECTION, STORAGE AND APPLICATIONS

Flat plate and concentrating collectors, classification of concentrating collectors, orientation and thermal analysis, advanced collectors; Different methods of storage: Sensible, latent heat and stratified storage, solar ponds. Solar Applications- solar heating/cooling technique, solar distillation and drying, photovoltaic energy conversion.

UNIT III: WIND ENERGY AND GEOTHERMAL ENERGY
Wind energy: Sources and potentials, horizontal and vertical axis windmills, performance characteristics, Betz criteria; Geothermel energy: Resources, types of wells, methods of harnessing the energy, potential in India.

UNIT IV: OCEAN ENERGY

OTEC, Principles utilization, setting of OTEC plants, thermodynamic cycles. Tidal and wave energy: Potential and conversion techniques, mini-hydel power plants, and their economics.

COURSE OUTCOME:

At the end of the course, a fully engaged student will be able to:

1. Understand the principles of solar energy and its environmental impact.
2. Learn the basics of solar energy collection and storage.
3. Study the basics of wind energy and geothermal energy.
4. Comprehend the use of ocean energy as an alternate source of energy.

REFERENCE BOOKS:

1. Renewable energy resources/ Tiwari and Ghosal/ Narosa.
2. Renewable Energy Technologies /Ramesh & Kumar /Narosa
3. Non-Conventional Energy Systems / K Mittal /Wheeler
4. Renewable energy sources and emerging technologies by D.P.Kothari,K.C.Singhal, P.H.I.
5. Non-Conventional Energy Sources /G.D. Rai, Khanna Publishers
6. Renewable Energy Resources – Twidell & Wier, CRC Press(Taylor & Francis)

OPEN ELECTIVE

COURSE CODE: OPHL-305A

INTRODUCTION TO ASTROPHYSICS AND COSMOLOGY

NO. OF CREDITS-3

		SESSIONAL:	25
L	P	THEORY EXAM:	75
3	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE:

To show how the properties of astronomical objects and the Universe relate to simple physical laws and processes

SYLLABUS

UNIT I :The Universe and its physics: A tour of the Universe, its scale and contents; Gravity; Pressure; Radiation Observational astronomy**:** the electromagnetic spectrum; geometrical optics; resolving power, and the diffraction limit; telescopes and detectors; gravitational waves; Distances**:** parallax measurements, standard candles

UNIT II: Physics of the Sun and Stars: blackbody radiation, the Planck, Stefan-Boltzmann and Wien laws, effective temperature, interstellar reddening; hydrogen spectral lines and Doppler effect; Hertzprung-Russell diagram; Freefall and Kelvin-Helmholtz time; nuclear fusion; basic stellar structure (hydrostatic equilibrium, equation of state); white dwarfs, neutron stars and black holes

UNIT III: Planetary systems: Kepler's laws; Detection methods of extrasolar planets; search for life elsewhere.

UNIT IV: Star formation: the interstellar medium; stellar populations; the interstellar medium; galaxy rotation curves, mass and dark matter; Galaxy collisions; central engines; Cosmology**:**Olber's paradox, Hubble's Law; the age of the Universe; Evolution of the Universe: Madau diagram; Evidence for the Big Bang (blackbody radiation, nucleosynthesis); dark energy and the accelerating Universe.

COURSE OUTCOMES

On completion successful students will be able to:

1. Have an understanding of the role and physics of detectors and telescopes including geometric optics and understand how distances are measured.
2. Know how basic laws of physics determine the properties and evolution of stars.
3. Know Kepler's Laws and how they relate to extrasolar planet detection.
4. Understand how the dynamics of galaxies indicate the presence of dark matter and demonstrate an understanding of the evolution of our Universe.

References:

1. Carroll, B.W. & Ostlie, D.A., *An Introduction to Modern Astrophysics* (Pearson)

OPEN ELECTIVE
COURSE CODE: OPHL-306A

PHYSICS AND OUR WORLD

SESSIONAL: 25

L	P		THEORY EXAM:	75
3	0		TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

The course aims to provide the students fundamentals of Physics and of our world

UNIT-I: Space and Time

A discussion on length scales and dimensions, Galaxies, The solar system and the planet Earth, Rotation and Revolution of the Earth, Seasons, Calendars in History and the recording of time, Laws of motions- A Discussions of principles, theories and models, Gravitation, Planetary motion and Keplar's Laws, the laws of motion in the eyes of Galileo and Newton.

UNIT-II: Theory of Relativity

The relationship between Space and time: A basic account of theory of Relativity, Does nature differentiate between left and right ?- The notion of Parity, Is there an "Arrow" of time?. Entropy and Laws of Thermodynamics, The Size of the Universe- Is the Universe expanding?

UNIT-III: Matter and Energy

Discrete and continuous matter- a brief historical survey, Atoms and molecule: Structure of atoms, the nucleus, Elementary particles, Unification of forces. Equivalence of matter and energy, Nuclear energy and thermodynamics power. The Periodic table of elements, chemical bonds and molecules, Large molecules and living matter.

UNIT-IV Electromagnetic Energy

Waves and oscillations, Electromagnetic radiation and spectrum, Propagation of waves, Energy in the atmosphere- Wind and solar energy, Weather predictability and chaos, Indeterminacy, The quantum world—an introduction, Debates on the conceptualization of physical realities- is nature unreasonably mathematical?

COURSE OUTCOME

On successful completion of this course, students should be able to :

- Understand the relation between space and time.

- Learn the about the elementary particles and equivalence of energy and matter
- Learn about matter and energy
- Comprehend the basics of Electromagnetic energy

REFERENCE BOOKS:

1. The Evolution of Physics-Einstein and L. Infeld, Toughstone 1967
2. The Ascent of Man-J. Bronowski, laffle and Brown Company, 1976
3. Commos- Carl sagan, McDonald and Company, 2003.

FACULTY OF SCIENCES

DEPARTMENT OF PHYSICS

B.Sc. (Hons.) Physics

w.e.f. Session 2017-2018

YMCA UNIVERSITY OF SCIENCE AND TECHNOLOGY

YMCA UNIVERSITY OF SCIENCE AND TECHNOLOGY

VISION

YMCA University of Science and Technology aspires to be a nationally and internationally acclaimed leader in technical and higher education in all spheres which transforms the life of students through integration of teaching, research and character building.

MISSION

- To contribute to the development of science and technology by synthesizing teaching, research and creative activities.
- To provide an enviable research environment and state-of-the art technological exposure to its Scholars.
- To develop human potential to its fullest extent and make them emerge as world class leaders in their professions and enthuse them towards their social responsibilities

HUMANITIES AND SCIENCES DEPARTMENT

VISION

A department that can effectively harness its multidisciplinary strengths to create an academically stimulating atmosphere; evolving into a well-integrated system that synergizes the efforts of its competent faculty towards imparting intellectual confidence that aids comprehension and complements the spirit of inquiry.

MISSION

- To create well-rounded individuals ready to comprehend scientific and technical challenges offered in the area of specialization.
- To counsel the students so that the roadmap becomes clearer to them and they have the zest to turn the blueprint of their careers into a material reality.
- To encourage critical thinking and develop their research acumen by aiding the nascent spirit for scientific exploration.
- Help them take economic, social, legal and political considerations when visualizing the role of technology in improving quality of life.
- To infuse intellectual audacity that makes them take bold initiatives to venture into alternative methods and modes to achieve technological breakthroughs.

B.Sc. (Hons.) Physics

Physics is the most fundamental of the sciences. New concepts, such as Quantum Mechanics and Relativity, are introduced at degree level in order to understand nature at the deepest level.

These theories have profound philosophical implications because they challenge our view of the everyday world. At the same time they have a huge impact on society since they underpin the technological revolution. While studying one of the most intellectually satisfying disciplines, you will acquire transferable skills including numeracy, problem solving, an ability to reason clearly and communicate well. Core physics topics include: Newtonian Dynamics, Wave Phenomena, The Material Universe, Working with Physics, Practical Physics and Maths for Physics, Electromagnetism, Condensed Matter, Quantum and Atomic Physics and Nuclear and Particle Physics.

A wide range of options is available including Medical Physics, Astronomy, Statistical and Low Temperature Physics and Surface Physics. You will also take Mathematics, Computing and Experimental Physics modules in support of these studies. The programme includes a one-semester project in one of the research groups.

PROGRAM OBJECTIVES

- Producing graduates who are well grounded in the fundamentals of Physics and acquisition of the necessary skills, in order to use their knowledge in Physics in a wide range of practical application.
- Developing creative thinking and the power of imagination to enable graduates work in research in academia and industry for broader application.
- Accommodating their relevant fields in allied disciplines and to allow the graduates of Physics to fit into the inter-disciplinary environment.
- Relating the training of Physics graduates to the employment opportunities within the country.

It also promotes research and creative activities of students by providing exposure to the realm of physical science and technical expertise. The B.Sc. (Hons.) programme in physics is designed to provide a thorough basic knowledge in physics at the under graduate level. Apart from the general topics in physics, many of the new topics included in the syllabus keeps the students abreast with the latest developments taking place in the field. Also the experiments chosen for each practical course is such that they bring out the concept of application of the theory in a practical situation. It also helps in creative thinking and self-learning.

PROGRAM OUTCOMES

After completion of the program, the students will:

- have a strong foundation of pure and applied Physics by means of various theoretical and laboratory work.
- Provide a systematic understanding of core physical concepts, principles and theories along with their applications.
- To visualize and analyze various real life problems using Physics.
- To develop analytical & soft skills, reasoning & quantitative aptitude.
- Apart from Physics as a major subject, students will have the basic knowledge of communication & environmental sciences.
- The students will be able to learn computer Science/Mathematics/Chemistry/Electronics as an elective subject.
- To develop a career in the field of Research & Development, Banking, Industry, Defence & Civil Services etc.

YMCA UNIVERSITY OF SCIENCE AND TECHNOLOGY, FARIDABAD
DEPARTMENT OF HUMANITIES AND SCIENCES
STRUCTURE AND SYLLABI OF B.Sc. (Hons.) PHYSICS (6 SEMESTER COURSE)

SEMESTER - I

Subject Code	Title	L	T	P	Internal Assessment	End-semester Examination	Total	Credits	Category Code
Discipline Core Course (DCC) – Compulsory									
BPH 101	Mathematical Physics-I	4	0	0	25	75	100	4	DCC
BPH 102	Mechanics	4	0	0	25	75	100	4	DCC
BPH 103	Mathematical Physics-I Lab	0	0	4	15	35	50	2	DCC
BPH 104	Mechanics Lab	0	0	4	15	35	50	2	DCC
Ability Enhancement Compulsory Course (AECC) – Compulsory									
BENG 101	English	2	0	0	25	75	100	2	AEC
Open Elective Course (OEC-I) - Select 1-paper & respective Lab (if any) of the following 4-disciplines									
OMTH 101	Calculus	5	1	0	25	75	100	6	OEC
OELC 101	Electronic circuit & PCB Designing	4	0	0	25	75	100	4	OEC
OCSC 101	Introduction to Programming	4	0	0	25	75	100	4	OEC
OCHE 101	Inorganic Chemistry	4	0	0	25	75	100	4	OEC
OELC 102	Electronic circuit & PCB Designing Lab	0	0	4	15	35	50	2	OEC
OCSC 102	Introduction to Programming Lab	0	0	4	15	35	50	2	OEC
OCHE 102	Inorganic Chemistry Lab	0	0	4	15	35	50	2	OEC
Massive Open Elective Course (MOOC)*- Online Compulsory Course in any one semester from Sem-I to Sem-V									
XXX	MOOC	4/6	0	0	25	75	100	4/6	MOOC
Total Credits								**20**	

*The students have to pass at least one mandatory MOOC course with 4-6 credits (12-16 weeks) from the list given on the Swayam portal or the list given by the department/ university from 1st semester to 3rd semester as notified by the university. (Instructions to students overleaf)
L – Lecture; T - Tutorial; P - Practical

SEMESTER - II

Subject Code	Title	L	T	P	Internal Assessment	End-semester Examination	Total	Credits	Category Code
Discipline Core Course (DCC) – Compulsory									
BPH 201	Electricity & Magnetism	4	0	0	25	75	100	4	DCC
BPH 202	Waves & Optics	4	0	0	25	75	100	4	DCC
BPH 203	Electricity & Magnetism Lab	0	0	4	15	35	50	2	DCC
BPH 204	Waves & Optics Lab	0	0	4	15	35	50	2	DCC
Ability Enhancement Compulsory Course (AECC) – Compulsory									
BEVS 101	Environmental Science	2	0	0	25	75	100	2	AEC
Open Elective Course (OEC-2) - Select 1- paper & respective Lab(if any) of the following 4-disciplines									
OMTH 201	Linear Algebra	5	1	0	25	75	100	6	OEC
OELC 201	Instrumentation	4	0	0	25	75	100	4	OEC
OCSC 201	Introduction to Database System	4	0	0	25	75	100	4	OEC
OCHE 201	Physical Chemistry	4	0	0	25	75	100	4	OEC
OELC 202	Instrumentation Lab	0	0	4	15	35	50	2	OEC
OCSC 202	Introduction to Database System Lab	0	0	4	15	35	50	2	OEC
OCHE 202	Physical Chemistry Lab	0	0	4	15	35	50	2	OEC
Massive Open Elective Course (MOOC) – Online Compulsory Course in any one semester from Sem-I to Sem-V									
XXX	MOOC	4/6	0	0	25	75	100	4/6	MOOC
Mandatory Audit Course (MAC)									
XXX	Audit Course#	2	0	0	25	75	100	0	AUD
Total Credits								**20**	

As per the list provided by University site

SEMESTER - III

Subject Code	Title	L	T	P	Internal Assessment	End-semester Examination	Total	Credits	Category Code
Discipline Core Course (DCC) – Compulsory									
BPH 301	Mathematical Physics-II	4	0	0	25	75	100	4	DCC
BPH 302	Thermal Physics	4	0	0	25	75	100	4	DCC
BPH 303	Analog Systems & Applications	4	0	0	25	75	100	4	DCC
BPH 304	Mathematical Physics-II Lab	0	0	4	15	35	50	2	DCC
BPH 305	Thermal Physics Lab	0	0	4	15	35	50	2	DCC
BPH 306	Analog Systems & Applications Lab	0	0	4	15	35	50	2	DCC
Skill Enhancement Course (SEC) – Select 1-paper and respective lab out of the following									
SECP 01	Computational Physics Skills	2	0	0	25	75	100	2	SEC
SECP 02	Electrical Circuits & Network Skills	2	0	0	25	75	100	2	SEC
SECP 03	Basic Instrumentation Skills	2	0	0	25	75	100	2	SEC
SECP 04	Computational Physics Skills Lab	0	0	2	15	35	50	0	SEC
SECP 05	Electrical Circuits & Network Skills Lab	0	0	2	15	35	50	0	SEC
SECP 06	Basic Instrumentation Skills Lab	0	0	2	15	35	50	0	SEC
Open Elective Course (OEC-3) – Select 1- paper & respective Lab(if any) of the following 4-disciplines									
OMTH 301	Differential Equations	5	1	0	25	75	100	6	OEC
OELC 301	Communication Systems	4	0	0	25	75	100	4	OEC
OCSC 301	Computer Networks & Internet Technology	4	0	0	25	75	100	4	OEC

OCHE 301	Organic Chemistry	4	0	0	25	75	100	4	OEC
OELC 302	Communication Systems Lab	0	0	4	15	35	50	2	OEC
OCSC 302	Computer Networks & Internet Technology Lab	0	0	4	15	35	50	2	OEC
OCHE 302	Organic Chemistry Lab	0	0	4	15	35	50	2	OEC
Massive Open Elective Course (MOOC) – Online Compulsory Course in any one semester from Sem-I to Sem-V									
XXX	MOOC	4/6	0	0	25	75	100	4/6	MOOC
Total Credits								**26**	

SEMESTER - IV

Subject Code	Title	L	T	P	Internal Assessment	End-semester Examination	Total	Credits	Category Code
Discipline Core Course (DCC) – Compulsory									
BPH 401	Mathematical Physics-III	4	0	0	25	75	100	4	DCC
BPH 402	Elements of Modern Physics	4	0	0	25	75	100	4	DCC
BPH 403	Digital Systems & Applications	4	0	0	25	75	100	4	DCC
BPH 404	Mathematical Physics-III Lab	0	0	4	15	35	50	2	DCC
BPH 405	Elements of Modern Physics Lab	0	0	4	15	35	50	2	DCC
BPH 406	Digital Systems & Applications Lab	0	0	4	15	35	50	2	DCC
Skill Enhancement Course (SEC) – Select 1-paper and respective Lab out of the following (not opted in Sem-III)									
SECP 01	Computational Physics Skills	2	0	0	25	75	100	2	AEEC
SECP 02	Electrical Circuits & Network Skills	2	0	0	25	75	100	2	AEEC
SECP 03	Basic Instrumentation Skills	2	0	0	25	75	100	2	AEEC
SECP 04	Computational Physics Skills Lab	0	0	2	15	35	50	0	SEC
SECP 05	Electrical Circuits & Network Skills Lab	0	0	2	15	35	50	0	SEC
SECP 06	Basic Instrumentation Skills Lab	0	0	2	15	35	50	0	SEC
Open Elective Course (OEC-3) – Select 1- paper & respective Lab (if any) of the following 4-disciplines									
OMTH 401	Numerical Methods	5	1	0	25	75	100	6	OEC
OELC 401	Microprocessor & Microcontroller Systems	4	0	0	25	75	100	4	OEC
OCSC 401	Information Security	4	0	0	25	75	100	4	OEC
OCHE 401	Spectroscopy	4	0	0	25	75	100	4	OEC
OELC 402	Microprocessor &	0	0	4	15	35	50	2	OEC

	Microcontroller Systems Lab								
OCSC 402	Information Security Lab	0	0	4	15	35	50	2	OEC
OCHE 402	Spectroscopy Lab	0	0	4	15	35	50	2	OEC
Massive Open Elective Course (MOOC) – Online Compulsory Course in any one semester from Sem-I to Sem-V									
XXX	MOOC	4/6	0	0	25	75	100	4/6	MOOC
Total Credits								**26**	

SEMESTER - V

Subject Code	Title	L	T	P	Internal Assessment	End-semester Examination	Total	Credits	Category Code
Discipline Core Course (DCC) – Compulsory									
BPH 501	Quantum Mechanics & Applications	4	0	0	25	75	100	4	DCC
BPH 502	Solid State Physics	4	0	0	25	75	100	4	DCC
BPH 503	Quantum Mechanics & Applications Lab	0	0	4	15	35	50	2	DCC
BPH 504	Solid State Physics Lab	0	0	4	15	35	50	2	DCC
Discipline Elective Course (DEC) select any 2-papers & respective labs (if any) out of the following 3-papers									
DECP 501	Atomic & Molecular Physics	5	1	0	25	75	100	6	DEC
DECP 502	Experimental Techniques	4	0	0	25	75	100	4	DEC
DECP 503	Linear Algebra & Tensor Analysis	5	1	0	25	75	100	6	DEC
DECP 504	Experimental Techniques Lab	0	0	4	15	35	50	2	DEC
DECP 505	Biological & Medical Physics	5	1	0	25	75	100	6	DEC
Massive Open Elective Course (MOOC) – Online Compulsory Course in any one semester from Sem-I to Sem-V									
XXX	MOOC	4/6	0	0	25	75	100	4/6	MOOC
Total Credits								**24**	

SEMESTER - VI

Subject Code	Title	L	T	P	Internal Assessment	End-semester Examination	Total	Credits	Category Code
Discipline Core Course (DCC) – Compulsory 2-Papers									
BPH 601	Electromagnetic Theory	4	0	0	25	75	100	4	DCC
BPH 602	Statistical Mechanics	4	0	0	25	75	100	4	DCC
BPH 603	Electromagnetic Theory Lab	0	0	4	15	35	50	2	DCC
BPH 604	Statistical Mechanics Lab	0	0	4	15	35	50	2	DCC
Discipline Elective Course (DEC) – Select any 2-papers & respective lab (if any) out of the following 3-papers									
DECP 601	Nuclear & Particle Physics	5	1	0	25	75	100	6	DEC
DECP 602	Nano Materials & Applications	4	0	0	25	75	100	4	DEC
DECP 603	Physics of Devices & Communication	4	0	0	25	75	100	6	DEC
DECP 604	Nano Materials & Applications Lab	0	0	4	15	35	50	2	DEC
DECP 605	Physics of Devices & Communication Lab	0	0	4	15	35	50	2	DEC
DECP 606	Classical Dynamics	5	1	0	25	75	100	6	DEC
Total Credits								**24**	

Grand Total Credits: 144/146 [140 + 4/6 (for MOOC Course)]

NOTE: 1. Discipline Elective Course (DEC) papers may be added or deleted as per UGC guidelines.
2. Skill Enhancement Course (SEC) papers may be added or deleted as per UGC guidelines.

Instructions to the students regarding MOOC

1. Two types of courses will be circulated: branch specific and general courses from the website https://swayam.gov.in in the month of June and November every year for the forthcoming semester.
2. The department coordinators will be the course coordinators of their respective departments.
3. Every student has to pass a selected MOOC course within the duration as specified below:

Programme	**Duration**
B. Tech.	Sem. I to Sem. VII
M.Sc./M.Tech./MA/MBA	Sem. I to Sem. III
B.Sc./MCA	Sem. I to Sem. V

The passing of a MOOC course is mandatory for the fulfilment of the award of the degree of concerned programme.

4. A student has to register for the course for which he is interested and eligible which is approved by the department with the help of course coordinator of the concerned department.
5. A student may register in the MOOC course of any programme. However, a UG student will register only in UG MOOC courses and a PG student will register in only PG MOOC courses.
6. The students must read all the instructions for the selected course on the website, get updated with all key dates of the concerned course and must inform his/her progress to their course coordinator.
7. The student has to pass the exam (online or pen-paper mode as the case may be) with at least 25% marks.
8. The students should note that there will be a weightage of Assessment/quiz etc. and final examination appropriately as mentioned in the instructions for a particular course.
9. A student must claim the credits earned in the MOOC course in his/her marksheet in the examination branch by forwarding his/her application through course coordinator and chairperson.

Syllabus of B.Sc. (H) Physics

Semester I

Discipline Core Course (DCC)

B.Sc. (H) Physics Sem-I
Paper: Mathematical Physics
Paper Code: BPH-101

No. of Credits: 4	**Sessional: 25**
L: 4, T: 0	**Theory Exam: 75**
Theory: 60 Lectures	**Total: 100**

COURSE OBJECTIVE

The emphasis of course is on applications in solving problems of interest to physicists. The students are to be examined entirely on the basis of problems based on mathematical physics, seen and unseen.

Calculus:

Plotting of functions. Approximation: Taylor and binomial series (statements only). First Order differential. Equations exact and inexact differential equations and Integrating Factor.

(6 Lectures)

Second Order Differential equations: Homogeneous Equations with constant coefficients. Wronskian and general solution. Particular Integral with operator method, method of undetermined coefficients and variation method of parameters. (15 Lectures)

Vector Algebra: Properties of vectors. Scalar product and vector product, Scalar triple product and their interpretation in terms of area and volume respectively. Scalar and Vector fields.

(6 Lectures)

Vector Calculus:

Vector Differentiation: Directional derivatives and normal derivative. Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field. Del and Laplacian operators. Vector identities. (10 Lectures)

Vector Integration: Ordinary Integrals of Vectors. Multiple integrals, Jacobian. Notion of infinitesimal line, surface and volume elements. Line, surface and volume integrals of Vector fields. Flux of a vector field. Gauss' divergence theorem, Green's and Stokes Theorems and their verification (no rigorous proofs). (14 Lectures)

Orthogonal Curvilinear Coordinates:

Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems. (7 Lectures)

Dirac Delta function:
Definition of Dirac delta function and simple examples. (2 Lectures)

Course Outcomes: After the completion of the course, students will be able to,

- Learn basic ideas of calculus
- Solve vector algebra and vector calculus problems
- Implementation of vector integration for solution of many Physics problems.
- Understand various coordinate systems and Dirac delta functions

Reference Books:

- Mathematical Methods for Physicists, G.B.Arfken, H.J.Weber, F.E.Harris,1513, 7th Edn., Elsevier.
- An introduction to ordinary differential equations, E.A. Coddington, 1509, PHI learning

- Differential Equations, George F. Simmons, 1507, McGraw Hill.
- Advanced Engineering Mathematics, D.G. Zill and W.S.Wright, 5 Ed., 1512, Jones and Bartlett Learning
- Mathematical Physics, Goswami, 1st edition, Cengage Learning
- Engineering Mathematics, S.Pal and S.C. Bhunia, 1515, Oxford University Press
- Advanced Engineering Mathematics, Erwin Kreyszig, 1508, Wiley India.

B.Sc. (H) Physics Sem-I
Paper: Mathematical Physics –I Lab
Paper Code: BPH-103

No. of Credits: 2 **Internal: 15**
L: 0, T: 0, P: 4 **External Exam: 35**
60 Periods **Total: 50**

COURSE OBJECTIVES: The aim of this Lab is not just to teach computer programming and numerical analysis but to emphasize its role in solving problems in Physics.

- Highlights the use of computational methods to solve physics problems
- The course will consist of lectures(both theory and practical) in the Lab
- Evaluation done not on the programming but on the basis of formulating the problem
- Students can use any one operating system Linux or Microsoft Windows
- At least two programs must be attempted from each programming section.

Topics	**Descriptions with Applications**
Errors and error Analysis	Truncation and round-off errors, Absolute and relative errors, Floating point computations

Review of C++ Programming fundamentals	Introduction to Programming, constants, variables and data types, operators and Expressions, I/O statements, cin and cout , Decision making and looping statements *(if-statement, if-else statement, nested if statement, else-if statement, ternary operator, goto statement, switch statement, unconditional and conditional looping, while and do while loop, for loop, nested loops, break and continue statements*). Arrays (1D and 2D) and strings, user defined functions,
Programs: using C++ language	Sum and average of a list of numbers, largest of a given list of numbers and its location in the list, sorting of numbers in ascending descending order, Binary search
Random number generation	Area of circle, area of square, volume of sphere, value of pi
Solution of Algebraic and Transcendental equations by Bisection, Newton Raphson and Secant methods	Solution of linear and quadratic equation, solving $\alpha = \tan \alpha$; $I = I_o (\sin \alpha/\alpha)^2$ in optics,
Interpolation by Newton Gregory Forward and Backward difference formula, Error estimation of linear interpolation	Evaluation of trigonometric functions e.g. $\sin \theta$, $\cos \theta$, $\tan \theta$ etc
Numerical differentiation (Forward and Backward difference formula) and Integration (Trapezoidal and Simpson rules), Monte Carlo Method	Given Position with equidistant time data calculate velocity and acceleration and vice versa. Find the area of BH Hysteresis loop
Solution of Ordinary Differential Equations (ODE) First order Differential equation Euler, modified Euler and Runge-Kutta (RK) second and fourth order methods	First order differential equation • Radioactive decay • Current in RC, LC circuits with DC source • Newton's law of cooling • Classical equations of motion Attempt following problems using RK 4 order method: • Solve the coupled differential equations $dx/dt = y + x - x^3/3$; $dy/dx = - x$ for four initial conditions $x(0) = 0$, $y(0) = -1, -2, -3, -4$. Plot x vs y for each of the four initial conditions on the same screen for $0 \leq t \leq 15$.

Referred Books:

- Introduction to Numerical Analysis, S.S. Sastry, 5th Edn., 1512, PHI Learning Pvt. Ltd.
- Schaum's Outline of Programming with C++. J.Hubbard, 1500 , McGraw-Hill Pub.
- Numerical Recipes in C++: The Art of Scientific Computing, W.H. Press et.al., 2nd Edn., 1513, Cambridge University Press.
- An introduction to Numerical methods in C++, Brian H. Flowers, 1509, Oxford University Press.
- A first course in Numerical Methods, U.M. Ascher & C. Greif, 1512, PHI Learning.
- Elementary Numerical Analysis, K.E. Atkinson,3rd Edn., 2007, Wiley India Edition.
- Computational Physics, Darren Walker, 1st Edn., 1515, Scientific International Pvt. Ltd.

B.Sc. (H) Physics Sem-I
Paper: Mechanics
Paper Code: BPH-102

No. of Credits: 4 | **Sessional: 25**
L: 4, T: 0 | **Theory Exam: 75**
Theory: 60 Lectures | **Total: 100**

COURSE OBJECTIVE
The emphasis of course is to understand laws of mechanics and their applications in various physical systems.

Fundamentals of Dynamics: Reference frames. Inertial frames, Review of Newton's Laws of Motion. Galilean transformations. Galilean invariance. Momentum of variable-mass system: motion of rocket. Motion of a projectile in uniform gravitational field. Dynamics of a system of particles. Centre of Mass. Principle of conservation of momentum. Impulse. **(7 Lectures)**

Work and Energy: Work and Kinetic Energy Theorem. Conservative and non-conservative forces. Potential Energy. Energy diagram. Stable and unstable equilibrium. Elastic potential energy. Force as gradient of potential energy. Work & Potential energy. Work done by non-conservative forces. Law of conservation of Energy. **(5 Lectures)**

Collisions: Elastic and inelastic collisions between particles. Centre of Mass and Laboratory frames.**(4 Lectures)**

Rotational Dynamics: Angular momentum of a particle and system of particles. Torque. Principle of conservation of angular momentum. Rotation about a fixed axis. Moment of

Inertia. Calculation of moment of inertia for rectangular, cylindrical and spherical bodies. Kinetic energy of rotation. Motion involving both translation and rotation. **(12 Lectures)**

Elasticity: Review of relation between Elastic constants. Twisting torque on a Cylinder or Wire (only qualitative discussion). **(2 Lectures)**

Gravitation: Law of gravitation. Gravitational potential energy. Inertial & gravitational mass. Potential and field due to spherical shell and solid sphere. **(3 Lectures)**

Central force Motion: Motion of a particle under a central force field. Two-body problem and its reduction to one-body problem and its solution. The energy equation and energy diagram. Kepler's Laws. Satellite in circular orbit & applications, weightlessness and basic idea of Global Positioning System (GPS). **(6 Lectures)**

Oscillations: Review of SHM (Simple Harmonic Oscillations. Differential equation of SHM and its solution. Kinetic energy, potential energy, total energy and their time - average values). Damped oscillation. Forced oscillations: Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor. **(7 Lectures)**

Non-Inertial Systems: Non-inertial frames and fictitious forces. Uniformly rotating frame. Laws of Physics in rotating coordinate systems. Centrifugal force. Coriolis force and its applications. **(4 Lectures)**

Special Theory of Relativity: Michelson-Morley Experiment and its outcome. Postulates of Special Theory of Relativity. Lorentz Transformations. Simultaneity and order of events. Lorentz contraction. Time dilation. Relativistic transformation of velocity, frequency and wave number. Relativistic addition of velocities. Variation of mass with velocity. Massless Particles. Mass-energy Equivalence. Relativistic Doppler effect. Relativistic Kinematics. Transformation of Energy & Momentum. **(10 Lectures)**

Course Outcomes: After the completion of the course, students will be able to,

- Learn fundamentals of Mechanics.
- Have a deep understanding of rotational dynamics & elasticity
- Understand the laws of gravitation and central force motion.
- Have a knowledge of how length, mass and time are relative to the velocity of an event.

Reference Books:

- An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.
- Mechanics, Berkeley Physics, vol.1, C. Kittel, W. Knight, et.al. 1507, Tata McGraw-Hill.
- Physics, Resnick, Halliday and Walker 8/e. 1508, Wiley.
- Analytical Mechanics, G.R. Fowles and G.L. Cassiday. 1505, Cengage Learning.
- Feynman Lectures, Vol.I, R.P.Feynman, R.B.Leighton, M.Sands, 1508, Pearson Education
- Mechanics, D.S. Mathur, S.Chand and Company Limited, 1500.
- Theoretical Mechanics, M.R. Spiegel, 1506, Tata McGraw Hill.

B.Sc. (H) Physics Sem-I
Paper: Mechanics Lab
Paper Code: BPH-104

No. of Credits: 2 | **Internal: 15**
L: 0, T: 0, P: 4 | **External Exam: 35**
60 Periods | **Total: 50**

Select at least 06 experiments from the following

1. To study the random error in observations.
2. To determine the height of a building using a Sextant.
3. To study the Motion of Spring and calculate (a) Spring constant, (b) **g** and (c) Modulus of rigidity.
4. To determine the Moment of Inertia of a Flywheel.
5. To determine **g** and velocity for a freely falling body using Digital Timing Technique
6. To determine the Young's Modulus of a Wire by Optical Lever Method.
7. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
8. To determine the elastic Constants of a wire by Searle's method.
9. To determine the value of g using Bar Pendulum.
10. To determine the value of g using Kater's Pendulum

Reference Books

- Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Edn, 1511,Kitab Mahal

Ability Enhancement Compulsory Course (AECC)

Semester- I
Paper: English
Paper Code: BENG-101

No. of Credits: 2 | **Sessional: 25**
L: 2, T: 0, P: 0 | **Theory Exam: 75**
Total: 100

Course Objectives:

1. To discuss communication process and elements of communication with the help of popular models.
2. To discuss types of communication.
3. To improve spoken English and ability to articulate ideas.
4. To improve comprehension
5. To improve formal writing skills.

Unit 1: Introduction: Theory of Communication, Types and modes of Communication

Unit 2: Language of Communication: Verbal and Non-verbal (Spoken and Written) Personal, Social and Business Barriers and Strategies Intra-personal, Inter-personal and Group communication

Unit 3: Speaking Skills: Monologue Dialogue Group Discussion Effective Communication/ Mis-Communication Interview Public Speech

Unit 4: Reading and Understanding Close Reading Comprehension Summary Paraphrasing Analysis and Interpretation Translation(from Indian language to English and vice-versa) Literary/Knowledge Texts

Unit 5: Writing Skills Documenting Report Writing Making notes Letter writing.

Course outcome:

After completion of course students would be able:

1.To learn about communication process and ways to make communication effective by giving attention to all elements involved.

2. To understand the value of verbal communication as well as non- verbal aspects of communication in making inter personnel communication effective and intrapersonnel communication insightful.

3.To gain confidence by enhancing their abilities to articulate their ideas.

4. To able to scan, skim and revise documents for fruitful reading and comprehension.

5. To acquire better writing skills in formal communication.

Recommended References Readings:

1.. Fluency in English - Part II, Oxford University Press, 2006.

2. Business English, Pearson, 2008.

3. Language, Literature and Creativity, Orient Blackswan, 2013.

4. Language through Literature (forthcoming) ed. Dr. Gauri Mishra, Dr Ranjana Kaul, Dr Brati Biswas

Open Elective Courses (OEC)

Semester-I

Open Elective Mathematics

Paper: CALCULUS

Paper Code: OMTH-101

NO. OF CREDITS: 6

		SESSIONAL:	25
L	T	THEORY EXAM:	75
5	1	TOTAL:	100

NOTE: Question paper has two parts. Part-1 has 10 questions each of 2 marks. It covers the entire syllabus. Attempt any four questions out of six from Part-2.

COURSE OBJECTIVES

To gain knowledge about differential calculus, curvature, asymptotes, partial differentiation, maxima-minima of functions of two variables, applications of single integral, double and triple integral.

UNIT I

Definition of limit, Continuity, types of discontinuity, Differentiability, Successive differentiation, Leibnitz's Theorem and applications, Taylor's & Maclaurin's Series for one variable, Asymptotes, Curvature, Radius of Curvature for Cartesian, Parametric and Polar-curves, Radius of curvature at the Origin (by using Newton‟s method, by method of Expansion), Centre of curvature, Curve Tracing.

UNIT II

Functions of two or more variables, Partial derivatives of first and higher order, Total differential and differentiability, Euler's theorem for Homogeneous functions, Derivatives of Composite and Implicit functions, Jacobians, Taylor's series for functions of two variables, Maxima-Minima of functions of two variables. Lagrange's Method of undetermined multipliers, Differentiation under the integral sign (Leibnitz rule).

UNIT III

Applications of Single integration to find volume of solids and surface area of solids by revolution, Double integral, Change of Order of Integration, Double integral in Polar co-ordinates, Applications of double integral to find (i) Area enclosed by plane curves (ii) Volume of solids of revolution.

UNIT IV

Triple Integral, Change of variables, Volume of solids, Beta & Gamma functions and relation between them.

COURSE OUTCOMES

- Acquire knowledge about differential calculus
- Acquire knowledge about partial differentiation and maxima-minima of functions of two variables
- Acquire knowledge about integral calculus: application of single integral, double integral and applications
- Acquire knowledge about triple integral and beta and gamma functions

BOOKS RECOMMENDED

- Shanti Narayan, Differential Calculus, S Chand Publisher
- Shanti Narayan, Integral Calculus, S Chand Publisher
- G.B. Thomas and R.L. Finney, Calculus, Pearson Education, 11/e (2012)
- H. Anton, I. Bivens and S. Davis, Calculus, John Willey and Sons Inc, 7/e (2011)

Semester--I

Open Elective Electronics

Paper: Electronic Circuits and PCB Designing

Paper CODE: OELC-101

Credits: Theory-04

		SESSIONAL:	25
L	T	THEORY EXAM:	75
4	0	TOTAL:	100

COURSE OBJECTIVES

To gain knowledge about fundamentals of analog Electronics for its applications in various electronic devices.

Unit-1 (12 Lectures)

Network theorems (DC analysis only): Review of Ohms law, Kirchhoff's laws, voltage divider and current divider theorems, open and short circuits.

Thevenin's theorem, Norton's theorem and interconversion, superposition theorem, maximum power transfer theorem.

Unit 2 (13 Lectures)

Semiconductor Diode and its applications: PN junction diode and characteristics, ideal diode and diode approximations. Block diagram of a Regulated Power Supply, Rectifiers: HWR, FWR-center tapped and bridge FWRs. Circuit diagrams, working and waveforms, ripple factor & efficiency(no derivations).Filters: circuit diagram and explanation of shunt capacitor filter with waveforms.

Zener diode regulator: circuit diagram and explanation for load and line regulation, disadvantages of Zener diode regulator.

Unit-3 (17 Lectures)

BJT and Small Signal amplifier: Bipolar Junction Transistor: Construction, principle & working of NPN transistor, terminology. Configuration: CE, CB, CC. Definition of α, β and γ and their interrelations, leakage currents. Study of CE Characteristics, Hybrid parameters.

Transistor biasing: need for biasing, DC load line, operating point, thermal runaway, stability and stability factor.

Voltage divider bias: circuit diagrams and their working, Q point expressions for voltage divider biasing.

Small signal CE amplifier: circuit, working, frequency response, re model for CE configuration, derivation for Av, Zin and Zout.

Unit-4 (18 Lectures)

Types of PCB: Single sided board, double sided, Multilayer boards, Plated through holes technology, Benefits of Surface Mount Technology (SMT), Limitation of SMT, Surface mount components: Resistors, Capacitor, Inductor, Diode and IC's.

Layout and Artwork: Layout Planning: General rules of Layout, Resistance, Capacitance and Inductance, Conductor Spacing, Supply and Ground Conductors, Component Placing and mounting, Cooling requirement and package density, Layout check.

Basic artwork approaches, Artwork taping guidelines, General artwork rules: Artwork check and Inspection.

Laminates and Photoprinting: Properties of laminates, Types of Laminates, Manual cleaning process, Basic printing process for double sided PCB's, Photo resists, wet film resists, Coating process for wet film resists, Exposure and further process for wet film resists, Dry film resists

Etching and Soldering: Introduction, Etching machine, Etchant system. Principles of Solder connection, Solder joints, Solder alloys, Soldering fluxes. Soldering, Desoldering tools and Techniques.

COURSE OUTCOMES

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

- Acquire knowledge about Network theorems.
- Learn about **Semiconductor Diode and its applications**
- **Know the working of BJT and Small Signal amplifier**
- Understand the fabrication and circuit designing on **PCB**

Suggested Books:

1. Electronic Devices and circuit theory, Robert Boylstead and Louis Nashelsky, 9th Edition, 2013, PHI
2. Electronics text lab manual, Paul B. Zbar.
3. Electric circuits, Joeseph Edminister, Schaum series.
4. Basic Electronics and Linear circuits, N.N. Bhargava, D.C. Kulshresta and D.C Gupta -TMH.
5. Electronic devices, David A Bell, Reston Publishing Company/DB Tarapurwala Publ.
6. Walter C.Bosshart ―PCB DESIGN AND TECHNOLOGY‖ Tata McGraw Hill Publications, Delhi. 1983
7. Clyde F.Coombs ―Printed circuits Handbook‖ III Edition, McGraw Hill.

Semester-I
Paper: Electronic Circuits and PCB Designing Lab
Paper Code: OELC-102

Credits: 2

L	P	T	Internal Exam:	15
			External Exam:	35
0	4	0	TOTAL:	50

COURSE OBJECTIVES

Electronic Circuits and PCB Designing Lab (Hardware and Circuit Simulation Software)

1. Verification of Thevenin‘s theorem
2. Verification of Super position theorem
3. Verification of Maximum power transfer theorem.
4. Half wave Rectifier – without and with shunt capacitance filter.
5. Centre tapped full wave rectifier – without and with shunt capacitance filter.
6. Zener diode as voltage regulator – load regulation.
7. Transistor characteristics in CE mode – determination of ri, ro and β.
8. Design and study of voltage divider biasing.
9. Designing of an CE based amplifier of given gain
10. Designing of PCB using artwork, its fabrication and testing.
11. Design, fabrication and testing of a 9 V power supply with zener regulator

Semester-I
Open Elective Chemistry
Paper: Inorganic Chemistry
Paper Code: OCHE-101

Credits: 02

L	T	SESSIONAL:	25
		THEORY EXAM:	75
4	0	TOTAL:	100

Course Objectives: To learn and understand the basic concepts of inorganic chemistry and its role in biological systems.

Unit I

Atomic Structure: *Review of: Bohr's theory and its limitations, Heisenberg Uncertainty principle*.

Dual behaviour of matter and radiation, de-Broglie's relation.Hydrogen atom spectra. Need of a new approach to Atomic structure.

What is Quantum mechanics? Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ^2, Schrödinger equation for hydrogen atom. Radial and angular parts of the hydogenicwavefunctions (atomic orbitals) and theirvariations for

1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Radial and angular nodes and their significance. Radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Significance of quantum numbers, orbital angular momentum and quantum numbers m_l and m_s. Shapes of *s*, *p* and *d* atomic orbitals, nodal planes. Discovery of spin, spin quantum number (*s*) and magnetic spin quantum number(m_s).

Rules for filling electrons in various orbitals, Electronic configurations of the atoms.Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.

Unit II

Chemical Bonding and Molecular Structure

Ionic Bonding*:* General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy (no derivation), Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ioniccharacter.

Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR (H_2O, NH_3, PCl_5, SF_6, ClF_3, SF_4) and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonalbipyramidal and octahedral arrangements.

Concept of resonance and resonating structures in various inorganic and organic compounds. MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for *s-s*, *s-p* and *p-p* combinations of atomic orbitals, nonbonding combination

of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of *s-p* mixing) and heteronuclear diatomic molecules such as CO, NO and NO^+.

Unit III

Organometallic Compounds

Definition and Classification with appropriate examples based on nature of metal-carbon bond (ionic, s, p and multicentre bonds). Structures of methyl lithium, Zeise'ssalt andferrocene. EAN rule as applied to carbonyls. Preparation, structure, bonding and properties of mononuclear and polynuclear carbonyls of 3d metals. p-acceptor behaviour of carbon monoxide. Synergic effects (VB approach)- (MO diagram of CO can be referred to for synergic effect to IRfrequencies).

Unit IV

Bio-Inorganic Chemistry

A brief introduction to bio-inorganic chemistry. Role of metal ions present in biological systems with special reference to Na^+, K^+ and Mg^{+2} ions: Na/K pump; Role of Mg^{+2} ions in energy production and chlorophyll. Role of iron in oxygen transport, haemoglobin, myoglobin, storage and transport of iron.

Course Outcomes:

After the successful completion of the course the learner would be able to

i. Understand the basic concept of atomic structure.
ii. Understand the chemical bonding concept.
iii. Understand the bonding and structure in organometallic compounds.
iv. Understand the role of inorganic chemistry in biological systems.

Reference Books:

- J. D. Lee: *A new Concise Inorganic Chemistry*, E L. B. S.17
- F. A. Cotton & G. Wilkinson: *Basic Inorganic Chemistry*, John Wiley.
- Douglas, McDaniel and Alexader: *Concepts and Models in Inorganic Chemistry*, John Wiley.
- James E. Huheey, *Ellen Keiter and Richard Keiter: Inorganic Chemistry: Principles of Structure and Reactivity*, Pearson Publication.

Semester-I
Open Elective Computer Science
Paper: INTRODUCTION TO PROGRAMMING
Paper Code: OCSE-101

Credits: 04

L	T		
		SESSIONAL:	25
L	T	THEORY EXAM:	75
4	0	TOTAL:	100

Theory: 60 lectures

Course Objectives

1. Be able to explain the difference between object oriented programming and procedural programming.
2. To familiarize students with the features of C language including data-types, variables, Operators ,Functions and Arrays.
3. Be able to program using more advanced C++ features such as composition of objects, operator overloading, dynamic memory allocation, inheritance and polymorphism, file I/O, exception handling, templates etc.
4. Be able to apply object oriented techniques to solve bigger Real World Computing problems.

Introduction to C and C++ 5L

History of C and C++, Overview of Procedural Programming and Object-Orientation Programming, Using main() function, Compiling and Executing Simple Programs in C++.

Data Types, Variables, Constants, Operators and Basic I/O 10L

Declaring, Defining and Initializing Variables, Scope of Variables, Using Named Constants, Keywords, Data Types, Casting of Data Types, Operators (Arithmetic, Logical and Bitwise), Using Comments in programs, Character I/O (getc, getchar, putc, putcharetc), Formatted and Console I/O (printf(), scanf(), cin, cout), Using Basic Header Files (stdio.h, iostream.h, conio.hetc).

Expressions, Conditional Statements and Iterative Statements 10L

Simple Expressions in C++ (including Unary Operator Expressions, Binary Operator Expressions), Understanding Operators Precedence in Expressions, Conditional Statements (if construct, switch-case construct), Understanding syntax and utility of Iterative Statements (while, do-while, and for loops), Use of break and continue in Loops, Using Nested Statements (Conditional as well as Iterative)

Functions and Arrays 10L

Utility of functions, Call by Value, Call by Reference, Functions returning value, Void functions, Inline Functions, Return data type of functions, Functions parameters, Differentiating between Declaration and Definition of Functions, Command Line Arguments/Parameters in Functions, Functions with variable number of Arguments.

Creating and Using One Dimensional Arrays (Declaring and Defining an Array, Initializing an Array, Accessing individual elements in an Array, Manipulating array elements using loops), Use Various types of arrays (integer, float and character arrays / Strings) Two- dimensional Arrays (Declaring, Defining and Initializing Two Dimensional Array, Working with Rows and Columns), Introduction to Multi-dimensional arrays

Derived Data Types (Structures and Unions) **5L**

Understanding utility of structures and unions, Declaring, initializing and using simple structures and unions, Manipulating individual members of structures and unions, Array of Structures, Individual data members as structures, Passing and returning structures from functions, Structure with union as members, Union with structures as members.

File I/O, Preprocessor Directives **8L**

Opening and closing a file (use of fstream header file, ifstream, ofstream and fstream classes), Reading and writing Text Files, Using put(), get(), read() and write() functions, Random access in files, Understanding the Preprocessor Directives (#include, #define, #error,

#if, #else, #elif, #endif, #ifdef, #ifndef and #undef), Macros

Using Classes in C++ **8L**

Principles of Object-Oriented Programming, Defining & Using Classes, Class Constructors, Constructor Overloading, Function overloading in classes, Class Variables &Functions, Objects as parameters, Specifying the Protected and Private Access, Copy Constructors, Overview of Template classes and their use.

Inheritance and Polymorphism **4L**

Introduction to Inheritance and Polymorphism

Course Outcomes

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

- **a.** Differentiate between Procedure-Oriented programming and Object-Oriented programming.
- **b.** Understand the syntax of the language.

c. Understand and apply various object oriented features like inheritance, data abstraction, encapsulation and polymorphism to solve various computing problems using C++ language.
d. Apply object oriented concepts in real world programs

Reference Books:

1. Herbtz Schildt, "C++: The Complete Reference", Fourth Edition, McGraw Hill.

2. E Balaguruswamy, "Object Oriented Programming with C++", Tata McGraw-Hill Education, 2008.

3. Paul Deitel, Harvey Deitel, "C++ How to Program", 8^{th} Edition, Prentice Hall, 2011.

4. John R. Hubbard, "Programming with C++", Schaum's Series, 2nd Edition, 2000.

Semester-I

Paper: INTRODUCTION TO PROGRAMMING LAB

Paper Code: OCSE-102

Credits: 2

L	P	T			
			Internal :	15
			External Exam:	35
0	4	0	TOTAL:	50

Introduction to Programming Lab

Practical: 60 lectures

1. Write a program to find greatest of three numbers.
2. Write a program to find gross salary of a person
3. Write a program to find grade of a student given his marks.
4. Write a program to find divisor or factorial of a given number.
5. Write a program to print first ten natural numbers.
6. Write a program to print first ten even and odd numbers.
7. Write a program to find grade of a list of students given their marks.
8. Create Matrix class. Write a menu-driven program to perform following Matrix operations (2-D array implementation):
   a) Sum b) Difference c) Product d) Transpose

Syllabus of B.Sc. (H) Physics

Semester II

Discipline Core Course (DCC)

B.Sc. (H) Physics Sem-II
Paper: ELECTRICITY AND MAGNETISM
Paper Code: BPH-201

No. of Credits: 4 | **Sessional: 25**
L: 4, T: 0 | **Theory Exam: 75**
Theory: 60 Lectures | **Total: 100**

COURSE OBJECTIVE
The objective of the course is to have an understanding the electricity and magnetism which later on makes the foundation of electromagnetic theory.

Electric Field and Electric Potential

Electric flux. Gauss' Law with applications to charge distributions with spherical, cylindrical and planar symmetry. Conservative nature of Electrostatic Field. Electrostatic Potential. Laplace's and Poisson equations. The Uniqueness Theorem. Potential and Electric Field of a dipole. Force and Torque on a dipole. **(7 Lectures)**

Electrostatic energy of system of charges. Electrostatic energy of a charged sphere. Conductors in an electrostatic Field. Surface charge and force on a conductor. Capacitance of a system of charged conductors. Parallel-plate capacitor. Capacitance of an isolated conductor. Method of Images and its application to: (1) Plane Infinite Sheet and (2) Sphere. **(9 Lectures)**

Dielectric Properties of Matter: Electric Field in matter. Polarization, Polarization Charges. Electrical Susceptibility and Dielectric Constant. Capacitor (parallel plate, spherical, cylindrical) filled with dielectric. Displacement vector **D**. Relations between **E**, **P** and **D**. Gauss' Law in dielectrics. **(9 Lectures)**

Magnetic Field: Ampere's Circuital Law and its application to (1) Solenoid and (2) Toroid. Properties of **B**: curl and divergence. Vector Potential. Magnetic Force on (1) point charge (2) current carrying wire (3) between current elements. Torque on a current loop in a uniform Magnetic Field. **(8 Lectures)**

Magnetic Properties of Matter: Magnetization vector (**M).** Magnetic Intensity(**H).** Magnetic Susceptibility and permeability. Relation between **B, H, M**. Ferromagnetism. B-H curve and hysteresis. **(4 Lectures)**

Electromagnetic Induction: Faraday's Law. Lenz's Law. Self Inductance and Mutual Inductance. Reciprocity Theorem. Energy stored in a Magnetic Field. Introduction to Maxwell's Equations. Charge Conservation and Displacement current. **(6 Lectures)**

Electrical Circuits: AC Circuits: Kirchhoff's laws for AC circuits. Complex Reactance and Impedance. Series LCR Circuit: (1) Resonance, (2) Power Dissipation and (3) Quality Factor, and (4) Band Width. Parallel LCR Circuit. **(7 Lectures)**

Network theorems: Ideal constant-voltage and constant-current Sources. Review of Kirchhoff's Current Law & Kirchhoff's Voltage Law. Mesh & Node Analysis. Thevenin theorem, Norton theorem, Superposition theorem, Reciprocity Theorem, Maximum Power Transfer theorem. Applications to dc circuits.**(10 Lectures)**

Course Outcomes: After the completion of the course, students will be able to,

- Know the basic concepts of electric field and potential
- Understand of dielectric behavior of matter
- Learn the laws of magnetism and electromagnetic induction.
- Have a deep understanding of electrical circuits and network theorems.

Reference Books:

- Electricity, Magnetism & Electromagnetic Theory, S.Mahajan and Choudhury, 1512, Tata McGraw
- Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education
- Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn., 1998, Benjamin Cummings.
- Feynman Lectures Vol.2, R.P.Feynman, R.B.Leighton, M.Sands, 1508, Pearson Education
- Electricity and Magnetism, J.H.Fewkes & J.Yarwood. Vol.I, 1991, Oxford Univ. Press.

B.Sc. (H) Physics Sem-II
Paper: ELECTRICITY AND MAGNETISM Lab
Paper Code: BPH-203

No. of Credits: 2 | **Internal : 15**
L: 0, P: 4, T: 0 | **External Exam: 35**
60 Periods | **Total: 50**

At least 6 experiments from the following

1. To study the characteristics of a series RC Circuit.
2. To determine an unknown Low Resistance using Potentiometer.
3. To determine an unknown Low Resistance using Carey Foster's Bridge.
4. To compare capacitances using De'Sauty's bridge.
5. Measurement of field strength B and its variation in a solenoid (determine dB/dx)
6. To verify the Thevenin and Norton theorems.
7. To verify the Superposition, and Maximum power transfer theorems.
8. To determine self inductance of a coil by Anderson's bridge.
9. To study response curve of a Series LCR circuit and determine its (a) Resonant frequency, (b) Impedance at resonance, (c) Quality factor Q, and (d) Band width.
10. To study the response curve of a parallel LCR circuit and determine its (a) Anti-resonant frequency and (b) Quality factor Q.
11. Measurement of charge sensitivity, current sensitivity and CDR of Ballistic Galvanometer
12. Determine a high resistance by leakage method using Ballistic Galvanometer.
13. To determine self-inductance of a coil by Rayleigh's method.
14. To determine the mutual inductance of two coils by Absolute method.

Reference Books

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
- A Text Book of Practical Physics, I.Prakash &Ramakrishna, 11^{th} Ed., 1511,Kitab Mahal
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4^{th} Edition, reprinted 1985, Heinemann Educational Publishers
- Engineering Practical Physics, S.Panigrahi and B.Mallick, 1515, Cengage Learning.

B.Sc. (H) Physics Sem-II
Paper: Waves & Optics
Paper Code: BPH-202

No. of Credits: 4 — **Sessional: 25**
L: 4, T: 0 — **Theory Exam: 75**
Theory: 60 Lectures — **Total: 100**

COURSE OBJECTIVE

The objective of the course is to have an understanding the of waves and optics which later on makes the foundation of spectroscopy.

Superposition of Collinear Harmonic oscillations: Simple harmonic motion (SHM). Linearity and Superposition Principle. Superposition of two collinear oscillations having

(1) equal frequencies and (2) different frequencies (Beats).Superposition of N collinear Harmonic Oscillations with (1) equal phase differences and (2) equal frequency differences. **(6 Lectures)**

Superposition of two perpendicular Harmonic Oscillations: Graphical and Analytical Methods. Lissajous Figures with equal and unequal frequencies and their uses. **(2 Lectures)**

Wave Motion: Plane and Spherical Waves. Longitudinal and Transverse Waves. Plane Progressive (Travelling) Waves. Wave Equation. Particle and Wave Velocities. Pressure of a Longitudinal Wave. Energy Transport. Intensity of Wave. **(4 Lectures)**

Superposition of Two Harmonic Waves: Standing (Stationary) Waves in a String: Fixed and Free Ends. Analytical Treatment. Phase and Group Velocities. Changes with respect to Position and Time. Energy of Vibrating String. Transfer of Energy. Normal Modes of Stretched Strings. Longitudinal Standing Waves and Normal Modes. **(8 Lectures)**

Interference: : Definition and properties of wave front. Huygens Principle. Temporal and Spatial Coherence. Division of amplitude and wavefront. Young's double slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment.

Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: Measurement of wavelength and refractive index. **(14 Lectures)**

Interferometer: Michelson Interferometer-(1) Idea of form of fringes (No theory required), (2) Determination of Wavelength, (3) Wavelength Difference, (4) Refractive Index, and (5) Visibility of Fringes. Fabry-Perot interferometer. **(6 Lectures)**

Fraunhofer diffraction: Single slit. Rectangular and Circular aperture, Resolving Power of a telescope. Double slit. Multiple slits. Diffraction grating. Resolving power of grating. (10 Lectures)

Fresnel Diffraction: Fresnel's Assumptions. Fresnel's Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Fresnel's Integral, Cornu`s spiral and its applications. Straight edge, a slit and a wire. **(10 Lectures)**

Course Outcomes: After the completion of the course, students will be able to,

- Understand the superposition of linear and perpendicular oscillations.
- Learn the basics of wave motion and SHM.
- Analyze interference phenomena in various systems.
- Know the phenomenon of Diffraction of light in various systems.

Reference Books

- Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 1507, Tata McGraw-Hill.
- Fundamentals of Optics, F.A. Jenkins and H.E. White, 1981, McGraw-Hill
- Principles of Optics, Max Born and Emil Wolf, 7th Edn., 1999, Pergamon Press.
- Optics, Ajoy Ghatak, 1508, Tata McGraw Hill
- The Physics of Vibrations and Waves, H. J. Pain, 1513, John Wiley and Sons.
- The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.
- Fundamental of Optics, A. Kumar, H.R. Gulati and D.R. Khanna, 1511, R. Chand Publications

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B.Sc. (H) Physics Sem-II
Paper: Waves & Optics Lab
Paper Code: BPH-204

No. of Credits: 2	**Internal: 15**
L: 0, T: 0, P: 4	**External Exam: 35**
60 Periods	**Total: 50**

At least 6 experiments from the following

1. To determine the frequency of an electric tuning fork by Melde's experiment and verify λ^2 –T law.
2. To investigate the motion of coupled oscillators.
3. To study Lissajous Figures.
4. Familiarization with: Schuster`s focusing; determination of angle of prism.
5. To determine refractive index of the Material of a prism using sodium source.

6. To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.
7. To determine the wavelength of sodium source using Michelson's interferometer.
8. To determine wavelength of sodium light using Fresnel's Biprism.
9. To determine wavelength of sodium light using Newton's Rings.
10. To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film.
11. To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating.
12. To determine dispersive power and resolving power of a plane diffraction grating.

Reference Books

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11^{th} Ed., 1511,Kitab Mahal
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4^{th} Edition, reprinted 1985, Heinemann Educational Publishers
- A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal,1985, Vani Pub.

Ability Enhancement Compulsory Course (AECC)

Semester- II

Environmental Science
Paper Code: BEVS- 101

No. of Credits: 2
L: 2, T: 0, P: 0

Internal: 25
External Exam: 75
Total: 100

Unit 1 : Introduction to environmental studies

- Multidisciplinary nature of environmental studies;
- Scope and importance; Concept of sustainability and sustainable development.

Unit 2 : Ecosystems

- What is an ecosystem? Structure and function of ecosystem; Energy flow in an ecosystem: food chains, food webs and ecological succession. Case studies of the following ecosystems :
  a) Forest ecosystem
  b) Grassland ecosystem
  c) Desert ecosystem
  d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Unit 3 : Natural Resources : Renewable and Non-renewable Resources

- Land resources and landuse change; Land degradation, soil erosion and desertification.
- Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations.
- Water : Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter-state).
- Energy resources : Renewable and non renewable energy sources, use of alternate energy sources, growing energy needs, case studies.

Unit 4 : Biodiversity and Conservation

- Levels of biological diversity : genetic, species and ecosystem diversity; Biogeographic zones of India; Biodiversity patterns and global biodiversity hot spots
- India as a mega-biodiversity nation; Endangered and endemic species of India
- Threats to biodiversity : Habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions; Conservation of biodiversity : In-situ and Ex-situ conservation of biodiversity.
- Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value.

Unit 5 : Environmental Pollution

- Environmental pollution : types, causes, effects and controls; Air, water, soil and noise pollution
- Nuclear hazards and human health risks

- Solid waste management : Control measures of urban and industrial waste.
- Pollution case studies.

Unit 6 : Environmental Policies & Practices

- Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture
- Environment Laws: Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act. International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD).
- Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context.

Unit 7 : Human Communities and the Environment

- Human population growth: Impacts on environment, human health and welfare.
- Resettlement and rehabilitation of project affected persons; case studies.
- Disaster management : floods, earthquake, cyclones and landslides.
- Environmental movements : Chipko, Silent valley, Bishnois of Rajasthan.
- Environmental ethics: Role of Indian and other religions and cultures in environmental conservation.
- Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi).

Unit 8 : Field work

- Visit to an area to document environmental assets: river/ forest/ flora/fauna, etc.
- Visit to a local polluted site-Urban/Rural/Industrial/Agricultural.
- Study of common plants, insects, birds and basic principles of identification.

Reference Books

1. Odum, E.P., Odum, H.T. & Andrews, J. 1971. *Fundamentals of Ecology*. Philadelphia: Saunders.
2. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2011. Environmental and Pollution Science. Academic Press.
3. Rao, M.N. & Datta, A.K. 1987. *Waste Water Treatment*. Oxford and IBH Publishing Co. Pvt. Ltd.
4. Sengupta, R. 2003. *Ecology and economics*: An approach to sustainable development. OUP.
5. Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. *Ecology, Environmental Science and Conservation*. S. Chand Publishing, New Delhi.
6. Sodhi, N.S., Gibson, L. & Raven, P.H. (eds). 2013. *Conservation Biology*: *Voices from the Tropics*. John Wiley & Sons.

Open Elective Courses (OEC)

Semester-II
Open Elective Mathematics
Paper: Linear Algebra
CODE: OMTH 201

L	T	SESSIONAL:	25
		THEORY EXAM:	75
5	1	TOTAL:	100

Total: 60 periods

COURSE OBJECTIVES

The aim of the course is to familiarize students with the concept of a Linear Transformation and its algebraic properties and the manipulative techniques necessary to use matrices and

determinants in solving applied problems. This course in linear algebra serves as a bridge from the typical intuitive treatment of calculus to more rigorous courses such as abstract algebra and analysis.

UNIT-I

Fundamental operation with vectors in Euclidean space $\mathbf{R}^n$, Linear combination of vectors, Dot product and their properties, Cauchy-Schwarz inequality, Triangle inequality, Projection of vectors, Some elementary results on vector in $\mathbf{R}^n$, Matrices, Echelon matrices, Row canonical form , Row equivalence, Rank, Linear combination of vectors, Row space, Eigenvalues, Eigenvectors, Eigenspace, Characteristic polynomials.

UNIT-II

Diagonalization of matrices. Definition and examples of vector space, Some elementary properties of vector spaces, Subspace, Span of a set, A spanning set for an eigenspace, Linear independence and linear dependence of vectors, Maximal linearly independent sets, Minimal spanning sets, Basis and dimension of a vector space.

UNIT-III

Application of rank, Homogenous and non homogenous systems of equations, Coordinates of a vector in ordered basis, Transition matrix .

Linear transformations: Definition and examples, Elementary properties, The matrix of a linear transformation, Linear operator and Similarity, Kernel and range of a linear transformation.

UNIT-IV

Dimension theorem, Oneto one and onto linear transformations, Invertible linear transformations. Isomorphism: Isomorphic vector spaces (to $\mathbf{R}^n$), Orthogonal and orthonormal vectors, Orthogonal and orthonormal bases, Orthogonal complement, Projection theorem (Statement only), Orthogonal projection onto a subspace.

COURSE OUTCOMES

After successful completion of the course students should be able to :

- Gauss–Jordan row reduction, Reduced row echelon form .
- Locate and use information to solve problems of linear transformations and vector spaces;
- Describe the concept of linear independence, linear transformation anddeterminants;
- Find eigenvalues and eigen vectors and Diagonalization of matrices.
- How to find Orthogonal and orthonormal bases

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Books Recommended:

[1] S. Andrilli and D. Hecker, Elementary Linear Algebra, Academic Press, 4/e (2012)
[2] B. Kolman and D.R. Hill, Introductory Linear Algebra with Applications, Pearson Education, 7/e (2003)

Semester-II

Open Elective Computer Science

Paper: Introduction to Database System

Paper Code: OCSC 201

Lecture 04, Tutorial :0	**Internal Assessment: 25**
Credit: 4	**End-semester Examination: 75**
Total Lectures: 60	**Total: 100**

Course Objectives:

1. The students will be able to understand basic terminology used in database systems, basic concepts, the applications of database systems and understand role of Database administrator in DBMS.
2. The students will be able to understand various data model like Hierarchical model, Network Model, Relational model, E-R model and will be able to make E-R diagram from data given by user and table from E-R diagram.
3. The students will be familiar with relational database theory and be able to write relational algebra expressions for query.
4. The students will be able to understand the logical design guidelines for databases, normalization approach, primary key, super key, foreign key concepts

Database: Introduction to database, relational data model, DBMS architecture, data independence, DBA, database users, end users, front end tools

E-R Modeling: Entity types, entity set, attribute and key, relationships, relation types, E- R diagrams, database design using ER diagrams

Relational Data Model: Relational model concepts, relational constraints, primary and foreign key, normalization: 1NF, 2NF, 3NF

Structured Query Language: SQL queries, create a database table, create relationships between database tables, modify and manage tables, queries, forms,

reports, modify, filter and view data.

Course Outcomes

The Student will be able

1. To understand the basic concepts, applications and architecture of database systems.
2. To master the basics of ER diagram.
3. To understand relational database algebra expressions and construct queries using SQL.
4. To understand sound design principles for logical design of databases, normalization.

Reference Books for Introduction to Database System

5. Fundamentals of Database Systems by R. Elmasri and S.B. Navathe, 3rd edition, 2000, Addision-Wesley, Low Priced Edition.
6. An Introduction to Database Systems by C.J. Date, 7th edition, Addison-Wesley, Low Priced Edition, 2000.
7. Database Management and Design by G.W. Hansen and J.V. Hansen, 2nd edition, 1999, Prentice-Hall of India, Eastern Economy Edition.
8. Database Management Systems by A.K. Majumdar and P. Bhattacharyya, 5th edition, 1999, Tata McGraw-Hill Publishing.
9. A Guide to the SQL Standard, Date, C. and Darwen,H. 3rd edition, Reading, MA: 1994, Addison-Wesley.
10. Data Management & file Structure by Loomis, 1989, PHI
11. P. Rob, C. Coronel, Database System Concepts by, Cengage Learning India, 2008

Semester-II
Subject: Introduction to Database System Lab
Subject Code: OCSC 202

L:0, T:0, P:4 — **Internal Assessment: 15**
Credit: 2 — **End-semester Examination: 35**
Total: 50

1) Create a database having two tables with the specified fields, to computerize a library system of a Delhi University College.

LibraryBooks (Accession number, Title, Author, Department, PurchaseDate, Price)
IssuedBooks (Accession number, Borrower)

a) Identify primary and foreign keys. Create the tables and insert at least 5 records in each table.

b) Delete the record of book titled “Database System Concepts”.

c) Change the Department of the book titled “Discrete Maths” to “CS”.

d) List all books that belong to “CS” department.

e) List all books that belong to “CS” department and are written by author “Navathe”.

f) List all computer (Department=”CS”) that have been issued.

g) List all books which have a price less than 500 or purchased between “01/01/1999” and “01/01/2004”.

2) Create a database having three tables to store the details of students of Computer Department in your college.

Personal information about Student (College roll number, Name of student, Date of birth, Address, Marks(rounded off to whole number) in percentage at 10 + 2, Phone number)

Paper Details (Paper code, Name of the Paper)

Student’s Academic and Attendance details (College roll number, Paper code, Attendance, Marks in home examination).

a) Identify primary and foreign keys. Create the tables and insert at least 5 records in each table.

b) Design a query that will return the records (from the second table) along with the name of student from the first table, related to students who have more than 75% attendance and more than 60% marks in paper 2.

c) List all students who live in “Delhi” and have marks greater than 60 in paper1. d) Find the total attendance and total marks obtained by each student.

e) List the name of student who has got the highest marks in paper2

3) Create the following tables and answer the queries given below:

Customer (CustID, email, Name, Phone, ReferrerID)

Bicycle (BicycleID, DatePurchased, Color, CustID, ModelNo)
BicycleModel (ModelNo, Manufacturer, Style)

Service (StartDate, BicycleID, EndDate)

a) Identify primary and foreign keys. Create the tables and insert at least 5 records in each table.

b) List all the customers who have the bicycles manufactured by manufacturer "Honda". c) List the bicycles purchased by the customers who have been referred by customer "C1".

d)List the manufacturer of red colored bicycles.

e)List the models of the bicycles given for service.

4) Create the following tables, enter at least 5 records in each table and answer the queries given below.

EMPLOYEE (Person_Name, Street, City)

WORKS (Person_Name, Company_Name, Salary)
COMPANY (Company_Name, City)

MANAGES (Person_Name, Manager_Name)

a)Identify primary and foreign keys.

b)Alter table employee, add a column "email" of type varchar(20).

c)Find the name of all managers who work for both Samba Bank and NCB Bank.

d) Find the names, street address and cities of residence and salary of all employees who work for "Samba Bank" and earn more than $10,000.

e) Find the names of all employees who live in the same city as the company for which they work.

f) Find the highest salary, lowest salary and average salary paid by each company.

g) Find the sum of salary and number of employees in each company.h) Find the name of the company that pays highest salary.

5) Create the following tables, enter at least 5 records in each table and answer the queries given below.

Suppliers (SNo, Sname, Status, SCity) Parts (PNo, Pname, Colour, Weight, City) Project (JNo, Jname, Jcity)

Shipment (Sno, Pno, Jno, Qunatity)

a) Identify primary and foreign keys.

b) Get supplier numbers for suppliers in Paris with status>20.

c) Get suppliers details for suppliers who supply part P2. Display the supplier list in increasing order of supplier numbers.

d) Get suppliers names for suppliers who do not supply part P2.

e) For each shipment get full shipment details, including total shipment weights. f) Get all the shipments where the quantity is in the range 300 to 750 inclusive.

g) Get part nos. for parts that either weigh more than 16 pounds or are supplied by suppliers S2, or both.

h) Get the names of cities that store more than five red parts.

i) Get full details of parts supplied by a supplier in London.

j) Get part numbers for part supplied by a supplier in London to a project in London. k) Get the total number of project supplied by a supplier (say, S1).

l) Get the total quantity of a part (say, P1) supplied by a supplier (say, S1)

Semester-II
Open Elective Chemistry
Paper: Physical Chemistry
Paper Code: OCHE 201

L-04 T-00
Credit: 4
Theory: 60 periods

Internal Assessment: 25
End-semester Examination: 75
Total Marks: 100

Course Objectives: To learn and understand the elements of physical chemistry and physical phenomenon.

Unit I
Chemical Energetics

Review of thermodynamics and the Laws of Thermodynamics.

Important principles and definitions of thermochemistry.Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution.Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data.Variation of enthalpy of a reaction with temperature – Kirchhoff's equation.Statement of Third Law of thermodynamics and calculation of absolute entropies of substances.

Unit I.

Chemical Equilibrim:

Free energy change in a chemical reaction.Thermodynamic derivation of the law of chemical equilibrium.Distinction between*G* and *G*o, Le Chatelier's principle. Relationships between*Kp, Kc*and *Kx*for reactions involving ideal gases.

Ionic Equilibria:

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts.Buffer solutions.Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

Unit III

Solutions

Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law – non-ideal solutions. Vapour pressure-composition and temperature- composition curves of ideal and non-ideal solutions. Distillation of solutions.Lever rule.Azeotropes.Partial miscibility of liquids: Critical solution temperature; effect of impurity on partial miscibility of liquids. Immiscibility of liquids- Principle of steam distillation.Nernst distribution law and its applications, solvent extraction.

Phase Equilibrium

Phases, components and degrees of freedom of a system, criteria of phase equilibrium.Gibbs Phase Rule and its thermodynamic derivation. Derivation of Clausius – Clapeyron equation and its importance in phase equilibria. Phase diagrams of one-componentsystems (water and sulphur) and two component systems involving eutectics, congruent and incongruent melting points (lead- silver, FeCl3-H2O and Na-Konly).

Unit IV

Electrochemistry

Reversible and irreversible cells.Concept of EMF of a cell.Measurement of EMF of a cell.Nernst equation and its importance.Types of electrodes.Standard electrode potential.Electrochemical series. Thermodynamics of a reversible cell, calculation of thermodynamic properties: *G, H* and *S* from EMFdata.Calculation of equilibrium constant from EMF data. Concentration cells with transference and without transference. Liquid junction potential and salt bridge.pH determination using hydrogen electrode and quinhydrone electrode.Potentiometric titrations -qualitative treatment (acid-base and oxidation-reduction only).

Course Outcomes:

After the successful completion of the course the learner would be able to

I. Understand the basic concept chemical thermodynamics
II. Understand chemical ionic equilibrium
III. Understand phase equilibrium
IV. Understand electrochemistry.

Reference Books

G. M. Barrow: *Physical Chemistry* Tata McGraw Hill (2007).
G. W. Castellan: *Physical Chemistry* 4th Edn. Narosa (2004).
J. C. Kotz, P. M. Treichel& J. R. Townsend: *General Chemistry* CengageLening India Pvt. Ltd., New Delhi (2009).
B. H. Mahan: *University Chemistry* 3rd Ed. Narosa (1998).
R. H. Petrucci: *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).

Syllabus of B.Sc. (H) Physics

Semester III

Discipline Core Course (DCC)

B.Sc.(H) Physics Sem-III
Paper: Mathematical Physics-II
Paper Code: BPH-301

No. of Credits: 4	**Sessional: 25**
L: 4, T: 0	**Theory Exam: 75**
Theory: 60 Lectures	**Total: 100**

Course objectives:
The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.

Fourier Series: Periodic functions. Orthogonality of sine and cosine functions, Dirichlet Conditions (Statement only). Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients. Even and odd functions and their Fourier expansions. Application. Summing of Infinite Series. Term-by-Term differentiation and integration of Fourier Series. Parseval Identity. (15 Lectures)

Power Series (Frobenius) Method and Special Functions: Singular Points of Second Order Linear Differential Equations and their importance. Frobenius method and its applications to differential equations. Legendre, Bessel, Hermite and Laguerre Differential Equations. Properties of Legendre Polynomials: Rodrigues Formula, Generating Function, Orthogonality. Simple recurrence relations.Expansion of function in a series of Legendre Polynomials. Bessel Functions of the First Kind: Generating Function, simple recurrence relations. Zeros of Bessel Functions ($J_o(x)$ and $J_1(x)$) and Orthogonality. (24 Lectures)

Some Special Integrals: Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. (6 Lectures)

Partial Differential Equations: Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular geometry.
Solution of wave equation for vibrational modes of a stretched string, rectangular and circular membranes. (15 Lectures)

Course Outcomes: After the completion of the course, students will be able to,

- Learn to analyze various complex functions in Fourier Series

- Solve LDE by power series method
- Learn various special functions for solution of many Physics problems.
- Learn special integral by Beta and Gamma functions.
- Understand to solve PDE used in many Physics problems.

Reference Books:

Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier. Fourier Analysis by M.R. Spiegel, 2004, Tata McGraw-Hill.
Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole. Differential Equations, George F. Simmons, 2006, Tata McGraw-Hill.
Engineering Mathematics, S.Pal and S.C. Bhunia, 2015, Oxford University Press

Mathematical methods for Scientists & Engineers, D.A.McQuarrie, 2003, Viva Books

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B.Sc.(H) Physics Sem-III
Paper: Mathematical Physics-II Lab
Paper Code: BPH-304

No. of Credits: 2 **Sessional: 15**
L: 0, T: 0, P: 4 **External Exam: 35**
Lab: 60 Periods **Total: 50**

Course Objectives: *The aim of this Lab is to use the computational methods to solve physical problems. The course will consist of lectures (both theory and practical) in the Computer Lab. Evaluation done not on the basis of programming but on the basis of formulating the problem. At least two programs must be attempted from each programming section.*

Topics	Description with Applications
Introduction to Numerical computation software Scilab	Introduction to Scilab, Advantages and disadvantages, Scilab environment, Command window, Figure window, Edit window, Variables and arrays, Initialising variables in Scilab, Multidimensional arrays, Sub-array, Special values, Displaying output data, data file, Scalar and array operations, Hierararchy of operations, Built in Scilab functions, Introduction to plotting, 2D and 3D plotting, Branching Statements and program design, Relational and logical operators, the while loop, for loop, details of loop operations, break and continue statements, nested loops, logical arrays and vectorization. User defined functions, Introduction to Scilab functions, Variable

	passing in Scilab, optional arguements, preserving data between calls to a function, Complex and Character data, String function, Multidimensional arrays an introduction to Scilab file processing, file opening and closing, Binary I/o functions, comparing binary and formatted functions, Numerical methods and developing the skills of writing a program.
Curve fitting, Least square fit, Goodness of fit, standard deviation using Scilab	Ohms law calculate R, Hookes law, Calculate spring constant, Given Bessel's function at N points find its value at an intermediate point
Solution of Linear system of equations by Gauss elimination method and Gauss Seidal method. Diagonalisation of matrices, Inverse of a matrix, Eigen vectors, eigen-values problems	Solution of mesh equations of electric circuits (3 meshes) Solution of coupled spring mass systems (3 masses)
Generation of Special functions using User defined functions in Scilab	Generating and plotting Legendre Polynomials Generating and plotting Bessel function
Solution of ODE First order Differential equation Euler, modified Euler and Runge-Kutta (RK) second and Fourth order methods Second order differential equation Fixed difference method Partial differential equations	First order differential equation: • Radioactive decay • Current in RC, LC circuits with DC source • Newton's law of cooling • Classical equations of motion Second order Differential Equation: • Harmonic oscillator (no friction) • Damped Harmonic oscillator (Overdamped, Critical damped, Oscillatory) • Forced Harmonic oscillator (Transient and Steady state solution) • Apply above to LCR circuits also Partial Differential Equation: • Wave equation • Heat equation • Poisson equation • Laplace equation
Using Scicos/xcos	• Generating sine wave, square wave, sawtooth wave • Solution of harmonic oscillator • Study of heat phenomenon • Phase space plots

Reference Books:

- Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press
- A Guide to MATLAB, B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, 2014, 3rd Edn., Cambridge University Press
- Getting started with Matlab, Rudra Pratap, 2010, Oxford University Press.
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A.V. Wouwer, P. Saucez, C.V. Fernández. 2014 Springer

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B.Sc.(H) Physics Sem-III
Paper: Thermal Physics
Paper Code: BPH-302

No. of Credits: 4 — **Sessional: 25**
L: 4, T: 0 — **Theory Exam: 75**
Theory: 60 Lectures — **Total: 100**

COURSE OBJECTIVE
The objective of the course is to have deep understanding the thermodynamics which later on makes the foundation for statistical Mechanics.

Introduction to Thermodynamics
Zeroth and First Law of Thermodynamics: Extensive and intensive Thermodynamic Variables, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics & Concept of Temperature, Concept of Work & Heat, State Functions, First Law of Thermodynamics and its differential form, Internal Energy, First Law & various processes, Applications of First Law: General Relation between C_P and C_V, Work Done during Isothermal and Adiabatic Processes (8 Lectures)

Second Law of Thermodynamics: Reversible and Irreversible process with examples. Conversion of Work into Heat and Heat into Work. Heat Engines. Carnot's Cycle, Carnot engine & efficiency. Refrigerator & coefficient of performance, 2nd Law of Thermodynamics: Kelvin-Planck and Clausius Statements. Carnot's Theorem. Applications of Second Law of Thermodynamics: Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale. (10 Lectures)

Entropy: Concept of Entropy, Second Law of Thermodynamics in terms of Entropy. Entropy of a perfect gas. Principle of Increase of Entropy. Entropy Changes in Reversible and Irreversible processes with examples. Entropy of the Universe. Entropy Changes in Reversible and Irreversible Processes. Temperature–Entropy diagrams for Carnot's Cycle. Third Law of Thermodynamics. Unattainability of Absolute Zero. (7 Lectures)

Thermodynamic Potentials: Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy. Their Definitions, Properties and Applications, First and second order Phase Transitions with examples, Clausius Clapeyron Equation (7 Lectures)

Maxwell's Thermodynamic Relations: Derivation of Maxwell's thermodynamic Relations and their applications, Maxwell's Relations: (1) Clausius Clapeyron equation, (2) Value of C_p-C_v, (3) TdS Equations, (4) Energy equations. (7 Lectures)

Kinetic Theory of Gases

Distribution of Velocities: Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy (No proof required). Specific heats of Gases. (7 Lectures)

Molecular Collisions: Mean Free Path. Collision Probability. Estimation of Mean Free Path. Transport Phenomenon in Ideal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion. Brownian Motion and its Significance. (4 Lectures)

Real Gases: Behavior of Real Gases: Deviations from the Ideal Gas Equation. Andrew's Experiments on CO_2 Gas. Critical Constants. Continuity of Liquid and Gaseous State. Vapour and Gas. Boyle Temperature. van der Waal's Equation of State for Real Gases. Values of Critical Constants. P-V Diagrams. Free Adiabatic Expansion of a Perfect Gas. Joule-Thomson Porous Plug Experiment. Joule-Thomson Effect for Real and van der Waal Gases. Temperature of Inversion. Joule-Thomson Cooling. (10 Lectures)

Course Outcomes: After the completion of the course, students will be able to,

- Know the basic laws of thermodynamics
- Understand of concept of entropy
- Learn various thermodynamic potentials and Maxwell's thermodynamic relations.
- Have an understanding of the kinetic theory of gases.
- Learn the behaviour of Real gases

Reference Books:

- Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill.
- A Treatise on Heat, Meghnad Saha, and B.N.Srivastava, 1958, Indian Press
- Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill
- Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa.
- Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. Chand Publications.

B.Sc.(H) Physics Sem-III
Paper: Thermal Physics Lab
Paper Code: BPH-305

No. of Credits: 2 | **Sessional: 15**
L: 0, P: 4 | **External Exam: 35**
Lab: 60 Periods | **Total: 50**

At least 5 experiments from the following

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.

2. To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus.

3. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.

4. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method.

5. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT).

6. To study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of its Two Junctions.

7. To calibrate a thermocouple to measure temperature in a specified Range using

(1) Null Method, (2) Direct measurement using Op-Amp difference amplifier and to determine Neutral Temperature.

Reference Books:

- Advanced Practical Physics for students, B. L. Flint and H.T.Worsnop, 1971, Asia Publishing House
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11^{th} Ed., 2011,Kitab Mahal Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4^{th} Edition, reprinted 1985, Heinemann Educational Publishers
- A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal,1985, Vani Pub.

B.Sc.(H) Physics Sem-III
Paper: ANALOG SYSTEMS AND APPLICATIONS
Paper Code: BPH-303

No. of Credits: 4 | **Sessional: 25**
L: 4, T: 0 | **Theory Exam: 75**
Theory: 60 Lectures | **Total: 100**

COURSE OBJECTIVE
The objective of the course is to have an understanding basic semiconductor physics and electronic devices which has a wide range of applications in science & technology.

Semiconductor Diodes: P and N type semiconductors. Energy Level Diagram. Conductivity and Mobility, Concept of Drift velocity.PN Junction Fabrication (Simple Idea). Barrier Formation in PN Junction Diode. Derivation of Barrier Potential, Barrier Width and Current for abrupt Junction. Current Flow Mechanism in Forward and Reverse Biased Diode. (9 Lectures)

Two-terminal Devices and their Applications: (1) Rectifier Diode: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, C-filter, (2) Zener Diode and Voltage Regulation. Principle, structure and characteristics of (1) LED, (2) Photodiode and (3) Solar Cell. (8 Lectures)

Bipolar Junction transistors: n-p-n and p-n-p Transistors. I-V characteristics of CB and CE Configurations. Active, Cut off and Saturation Regions. Current gains α and β. Relations between α and β. Load Line analysis of Transistors. DC Load line and Q-point. Physical Mechanism of Current Flow. (8 Lectures)

Amplifiers: Transistor Biasing and Stabilization Circuits. Fixed Bias and Voltage Divider Bias. Transistor as 2-port Network, h-parameter Equivalent Circuit. Analysis of a single-stage CE amplifier using Hybrid Model. Input and Output Impedance. Current, Voltage and Power Gains. Classification of Class A, B & C Amplifiers. Two stage RC-coupled amplifier and its frequency response. (13 Lectures)

Feedback in Amplifiers: Positive and Negative Feedback. Effect of negative feedback on Input Impedance, Output Impedance, Gain, Stability, Distortion, Noise and band width. (4 Lectures)
Sinusoidal Oscillators: Barkhausen's Criterion for self-sustained oscillations. RC Phase shift oscillator, determination of Frequency.Hartley & Colpitts oscillators. (7 Lectures)

Operational Amplifiers (Black Box approach) & its applications : Characteristics of an Ideal and Practical Op-Amp. (IC 741) Open-loop and Closed-loop Gain. Frequency Response. CMRR. Slew Rate and concept of Virtual ground. Applications of Op-Amps: (1) Inverting and non-inverting amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator, (5) Integrator, (6) Log amplifier, (7) Comparator and Zero crossing detector (10 Lectures)

Conversion: D/A Resistive networks (Weighted and R-2R Ladder). A/D conversion, Accuracy and Resolution. (5 Lectures)

Course Outcomes: After the completion of the course, students will be able to,

- Know the basics of Semiconductor physics and P-N diode and rectifiers and filters.
- Understand the characteristics of BJT in various configurations.
- Learn the process of amplification and feedback in amplifiers.
- Have an understanding of the physics of Op-Amp and its applications .

Reference Books:

- Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
- Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
- Solid State Electronic Devices, B.G.Streetman & S.K.Banerjee, 6th Edn.,2009, PHI Learning
- Electronic Devices & circuits, S.Salivahanan & N.S.Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill
- OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall
- Microelectronic circuits, A.S. Sedra, K.C. Smith, A.N. Chandorkar, 2014, 6th Edn., Oxford University Press.
- Semiconductor Devices: Physics and Technology, S.M. Sze, 2nd Ed., 2002, Wiley India.
- Microelectronic Circuits, M.H. Rashid, 2nd Edition, Cengage Learning
- Microelectronic Devices & Circuits, David A.Bell, 5th Edn.,2015, Oxford University Press

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B.Sc.(H) Physics Sem-III
Paper: ANALOG SYSTEMS AND APPLICATIONS Lab
Paper Code: BPH-306

No. of Credits: 2	**Sessional: 15**
L: 0, P: 4	**External Exam: 35**
Lab: 60 Periods	**Total: 50**

At least 08 experiments from the following:

1. To study the V-I characteristics of a Zener diode and its use as voltage regulator.

2. Study of V-I & power curves of solar cells, and find maximum power point & efficiency.

3. To study the characteristics of a Bipolar Junction Transistor in CE configuration.

4. To study the various biasing configurations of BJT for normal class A operation.
5. To design a CE transistor amplifier of a given gain (mid-gain) using voltage divider bias.

6. To study the frequency response of voltage gain of a two stage RC-coupled transistor amplifier.

7. To design a Wien bridge oscillator for given frequency using an op-amp.

8. To design a phase shift oscillator of given specifications using BJT.

9. To design a digital to analog converter (DAC) of given specifications.

10. To design an inverting amplifier using Op-amp (741, 351) for dc voltage of given gain

11. (a) To design inverting amplifier using Op-amp (741, 351) & study its frequency response

    (b) To design non-inverting amplifier using Op-amp (741, 351) & study frequency response

12. (a) To add two dc voltages using Op-amp in inverting and non-inverting mode

    (b) To study the zero-crossing detector and comparator.

13. To design a precision Differential amplifier of given I/O specification using Op-amp.

14. To investigate the use of an op-amp as an Integrator.

15. To investigate the use of an op-amp as a Differentiator.

16. To design a circuit to simulate the solution of simultaneous equation and $1^{st}/2^{nd}$order differential equation.

Reference Books:

- Basic Electronics: A text lab manual, P.B.Zbar, A.P.Malvino, M.A.Miller, 1994, Mc-Graw Hill.
- OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4^{th} edition, 2000, Prentice Hall.
- Electronic Principle, Albert Malvino, 2008, Tata Mc-Graw Hill.
- Electronic Devices & circuit Theory, R.L.Boylestad & L.D.Nashelsky, 2009, Pearson

Open Elective Courses (OEC)

Semester-III
Open Elective Computer Science
Paper: Computer Networks and Internet Technologies
Paper Code: OCSC-301

Credits: 04

L	T		
		SESSIONAL:	25
		THEORY EXAM:	75
4	0	TOTAL:	100

Theory: 60 lecture

Course Objectives:

1. The students will be able to understand basic computer network technology, different types of network topologies and protocols.
2. The students will be able to enumerate the layers of the OSI model and TCP/IP and analyze the services and features of the various layers of data networks.
3. The students will be able to learn services and protocols of physical and data link layer and understand IEEE 802 standards.
4. The students will be able to understand and building the skills of subnetting and routing mechanisms. Design, calculate, and apply subnet masks and addresses to fulfill networking requirements.
5. The students will be able to understand Internet Terms , Internet Applications and understand basics of HTML and JavaScript

Computer Networks: Introduction to computer network, data communication, components of data communication, data transmission mode, data communication measurement, LAN, MAN, WAN, wireless LAN, internet, intranet, extranet. 6L

Network Models: Client/ server network and Peer-to-peer network, OSI, TCP/IP, layers and functionalities. 8L

Transmission Media: Introduction, Guided Media: Twisted pair, Coaxial cable, Optical fiber. Unguided media: Microwave, Radio frequency propagation, Satellite 4L

LAN Topologies : Ring, Bus, Star , Mesh and tree topologies **2L**

Network Devices: NIC, repeaters, hub, bridge, switch, gateway and router 2L

Internet Terms: Web page, Home page, website, internet browsers, URL, Hypertext, ISP, Web server, download and upload, online and offline. 2L

Internet Applications: www, telnet, ftp, e-mail, social networks, search engines, Video Conferencing, e-Commerce, m-Commerce, VOIP, blogs. 6L

Introduction to Web Design: Introduction to hypertext markup language (html) Document type definition, creating web pages, lists, hyperlinks, tables, web forms, inserting images, frames, hosting options and domain name registration. Customized Features: Cascading style sheet (css) for text formatting and other manipulations. 16L

JavaScript Fundamentals: Data types and variables, functions, methods and events, controlling program flow, JavaScript object model, built-in objects and operators. 14L

Course Outcomes

1. To understand the terminology, concepts of the OSI reference model and the TCP-IP reference model and protocols, design issues in local area networks and wide area networks
2. To be familiar with protocols and issues at physical and data link layer including various IEEE standards.
3. To have a good understanding of the IP Addressing ,network applications and network devices
4. To create web pages using HTML and JavaScript.

Reference Books:

1. Computer networks – Tannenbaum
2. Data Communication and Networking – Forouzan – Tata McGraw Hill.
3. D.R. Brooks, An Introduction to HTML and Javascript for Scientists and Engineers, Springer W. Willard, 4.HTML A Beginner's Guide, Tata McGraw-Hill Education, 2009.
4. J. A. Ramalho, Learn Advanced HTML 4.0 with DHTML, BPB Publications, 2007

Semester-III

Paper: Computer Networks and Internet Technologies Lab

Paper code: OCSC-302

Credits: 02		**SESSIONAL:**	**15**
L	P	THEORY EXAM:	35
0	4	TOTAL:	50

Practical: 60 lectures

Practical exercises based on concepts listed in theory using HTML.

1. Create HTML document with following formatting – Bold, Italics, Underline, Colors, Headings, Title, Font and Font Width, Background, Paragraph, Line Brakes, Horizontal Line, Blinking text as well as marquee text.

2. Create HTML document with Ordered and Unordered lists, Inserting Images, Internal and External linking

3. Create HTML document with Table:

<table>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="3"></td><td colspan="2" rowspan="3">Some image here</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td colspan="3"></td></tr>
</table>

4. Create Form with Input Type, Select and Text Area in HTML.

5. Create an HTML containing Roll No., student's name and Grades in a tabular form.

6. Create an HTML document (having two frames) which will appear as follows:

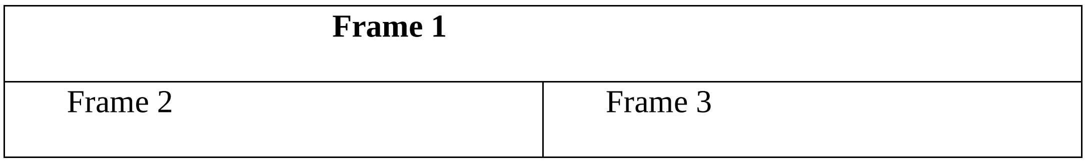
About Department 1 Department 2 Department 3	This frame would show the contents according to the link clicked by the user on the left frame

7. Create an HTML document containing horizontal frames as follows:

Department Names (could be along with Logos)
Contents according to the Link clicked

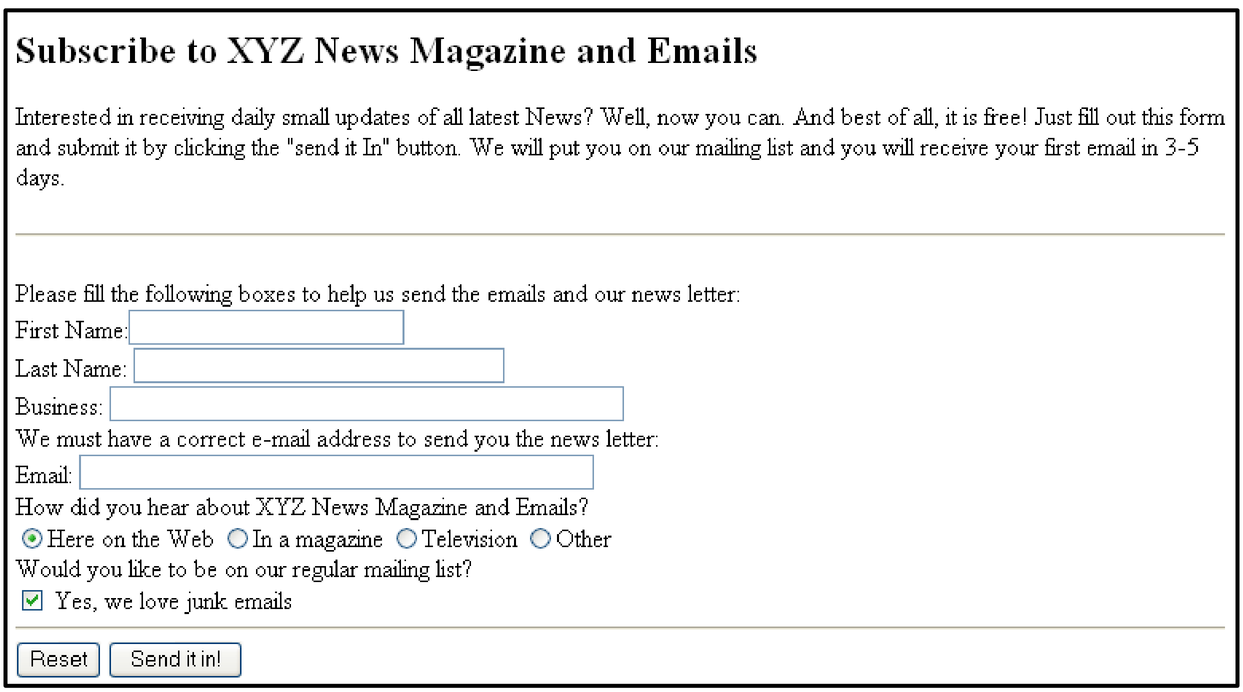
8. Create a website of 6 – 7 pages with different effects as mentioned in above problems.

9. Create HTML documents (having multiple frames) in the following formats



10. Create a form using HTML which has the following types of controls:

I. Text Box
II. Option/radio buttons
III. Check boxes
IV. IV. Reset and Submit buttons



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Here on the Web In a magazine Television Other
Would you like to be on our regular mailing list?
Yes, we love junk emails

Reset Send it in!

List of Practicals using Javascript :

Create event driven program for following:

1. Print a table of numbers from 5 to 15 and their squares and cubes using alert.

2. Print the largest of three numbers.
3. Find the factorial of a number n.
4. Enter a list of positive numbers terminated by Zero. Find the sum and average of these numbers.
5. A person deposits Rs 1000 in a fixed account yielding 5% interest. Compute the amount in theaccount at the end of each year for n years.
6. Read n numbers. Count the number of negative numbers, positive numbers and zeros in the list

Semester-III
Open Elective Mathematics
Paper: DIFFERENTIAL EQUATIONS
Paper Code: OMTH-301

Credits: 06

		SESSIONAL:	25
L	T	THEORY EXAM:	75
5	1	TOTAL:	100

Theory: 75 Lectures

COURSE OBJECTIVE

The course is designed to develop in students:

Appreciation for ODE and system of ODEs concepts that are encountered in the real world, understand and be able to communicate the underlying mathematics involved to help another person gain insight into the situation, work with Differential Equations and use correct mathematical terminology, notation, and symbolic processes in order to engage in work, study, and conversation on topics involving Differential equations. The students will learn to solve exact differential equations, linear differential equations and series solution of differential equations.

UNIT-I

First order ordinary differential equations: Basic concepts and ideas, Exact differential equations, Integrating factors, Bernoulli equations, Orthogonal trajectories of curves, Existence and uniqueness of solutions, Second order differential equations: Homogenous linear equations of second order, Second order homogenous equations with constant coefficients, Differential operator, Euler-Cauchy equation.

UNIT-II

Existence and uniqueness theory, Wronskian , Nonhomogenous ordinary differential equations, Solution by undetermined coefficients, Solution by variation of parameters, Higher order homogenous equations with constant coefficients, System of differential equations, System of differential equations, Conversion of n th order ODEs to a system, Basic concepts and ideas, Homogenous system with constant coefficients.

UNIT-III

Power series method: Theory of power series methods, Solution of differential equations by power series method, Legendre's equation, Legendre polynomial

UNIT IV

Partial differential equations: Basic Concepts and definitions, Mathematical problems, First order equations: Classification, Construction, Geometrical interpretation, Method of characteristics, General solutions of first order partial differential equations, Canonical forms and method of separation of variables for first order partial differential equations, Classification of second order partial differential equations, Reduction to canonical forms, Second order partial differential equations with constant coefficients, General solutions.

COURSE OUTCOMES:

Upon completion of course, students will be able to:

- Solve exact differential equations and linear differential equations.
- Solve differential equations by method of variation of parameters.
- Solve homogeneous and non- homogeneous differential equations.
- Solve partial differential equations.

REFERENCES:

- Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, Inc., 9/e, (2006)
- Tyn Myint–U and Lokenath Debnath; Linear Partial Differential Equations for Scientists and Engineers, Springer, Indian Reprint (2009)
- C.H. Edwards and D.E. Penny, Differential Equations and Boundary Value problems Computing and Modeling, Pearson Education India, 2005.
- S.L. Ross, *Differential Equations*, 3rd Ed., John Wiley and Sons, India, 2004.

Semester-III
Open Elective Electronics
Paper: Communication Systems
Paper Code: OELC-301

Credits: 04

L	T		
		SESSIONAL:	25
L	T	THEORY EXAM:	75
4	0	TOTAL:	100

Theory: 60 lecture

Unit-1 (16 Lectures)

Noise and Transmission lines: Noise-Introduction, internal and external noises, signal to noise ratio and noise figure

Amplitude Modulation/demodulation techniques: Block diagram of electronic communication system. Modulation-need and types of modulation-AM, FM & PM. Amplitude modulation – representation, modulation index, expression for instantaneous voltage, power relations, frequency spectrum, DSBFC, DSBSC and SSBSC (mention only). Limitations of AM.
Demodulation- AM detection: principles of detection, linear diode, principle of working and waveforms.
Block diagram of AM transmitter and Receiver.

Unit-2 (12 Lectures)

Frequency Modulation/demodulation techniques: Frequency Modulation: definition, modulation index, FM frequency spectrum diagram, bandwidth requirements, frequency deviation and carrier swing, FM generator-varactor diode modulator.
FM detector – principle, slope detector-circuit, principle of working and waveforms. Block diagram of FM transmitter and Receiver. Comparison of AM and FM.

Unit- 3(16 Lectures)

Digital communication: Introduction to pulse and digital communications, digital radio, sampling theorem, types- PAM, PWM, PPM, PCM – quantization, advantages and applications, digital modulations (FSK, PSK, and ASK). Advantage and disadvantages of digital transmission, characteristics of data transmission circuits – Shannon limit for information capacity, bandwidth requirements, data transmission speed, noise, cross talk, echo suppressors, distortion and equalizer, MODEM– modes, classification, interfacing (RS232). TDMA, FDMA, CDMA concepts, comparison of TDMA and FDMA

Unit- 4(16 Lectures)

Cellular Communication: Concept of cellular mobile communication – cell and cell splitting, frequency bands used in cellular communication, absolute RF channel numbers (ARFCN), frequency reuse, roaming and hand off, authentication of the SIM card of the subscribers, IMEI number, concept of data encryption, architecture (block diagram) of cellular mobile communication network, CDMA technology, CDMA overview, simplified block diagram of cellular phone handset, Comparative study of GSM and CDMA, 2G, 3G and 4G concepts.
Satellite communication: Introduction, to Orbit, types of orbits, Block diagram of satellite transponder.

Course Outcomes: After the completion of the course, students will be able to,

- Know amplitude modulation an demodulation techniques in detail
- Understand frequency modulation an demodulation techniques in detail
- Learn various digital communication techniques.
- Have an understanding of cellular communication and satellite communication.

Suggested Books:

1. Electronic Communication, George Kennedy, 3rd edition, TMH.
2. Electronic Communication, Roddy and Coolen, 4th edition, PHI.
3. Electronic Communication systems, Kennedy & Davis, IV edition-TATA McGraw Hill.
4. Advanced Electronic Communication systems, Wayne Tomasi- 6th edition, Low priced edition- Pearson education

Semester-III

Paper: Communication Systems Lab

Paper code: OELC-302

Credits: 02		**SESSIONAL:**	**15**
L	P	THEORY EXAM:	35
0	4	TOTAL:	50

Practical: 60 lectures

1. Amplitude modulator and Amplitude demodulator
2. Study of FM modulator using IC8038
3. Study of VCO using IC 566
4. Study of Time Division Multiplexing and de multiplexing
5. Study of AM Transmitter/Receiver
6. Study of FM Transmitter/Receiver
7. ASK modulator and demodulator
8. Study of FSK modulation
9. Study of PWM and PPM
10. Study of PAM modulator and demodulator

Semester-III
Open Elective Chemistry
Paper: Organic Chemistry
Paper Code: OCHE-301

Credits: 04

L	T		
4	0	SESSIONAL:	25
		THEORY EXAM:	75
		TOTAL:	100

Course Objectives: To learn and understand the basic concepts Organic chemistry.

Unit I

Fundamental of organic chemistry

Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis.
Reaction intermediates: Carbocations, Carbanions and free radicals. Electrophiles and nucleophiles
Aromaticity: Benzenoids and Hückel's rule.

Stereochemistry

Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L; *cis - trans* nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems).

Unit II

Aliphatic Hydrocarbons

Functional group approach for the following reactions (preparations physical property & chemical reactions) to be studied with mechanism in context to their structure.

Alkanes: *Preparation:* Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, Grignard reagent. *Reactions:* Free radical Substitution: Halogenation.

Alkenes: *Preparation:* Elimination reactions: Dehydration of alcohols and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). *Reactions:* cis-addition (alk. $KMnO_4$) andtrans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymecuration-demercuration, Hydroboration-oxidation.

Alkynes: *Preparation:* Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides. *Reactions:* formation of metal acetylides and acidity of alkynes, addition of bromine and alkaline $KMnO_4$, ozonolysis and oxidation with hot alk. $KMnO_4$. Hydration to form carbonyl compounds

Unit III

Aromatic hydrocarbons

Preparation (benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid.
Reactions: (benzene): Electrophilic substitution reactions: nitration, halogenation sulphonation. Friedel-Craft's reaction (alkylation and acylation) Side chain oxidation of alkyl benzenes.

Alkyl Halides .
Preparation: from alkenes *and* alcohols.

Reactions: Types of Nucleophilic Substitution (SN1, SN2 and SNi) reactions, hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson's ether synthesis: Elimination vs substitution.
Aryl Halides *Preparation:* (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer & Gattermann reactions.
Reactions (Chlorobenzene): Aromatic electrophilic and nucleophilic substitution (replacement by –OHgroup) and effect of nitro substituent. Benzyne Mechanism: KNH2/NH3 (or NaNH2/NH3).
Relative reactivity of alkyl, allyl, benzyl, vinyl and aryl halides towards Nucleophilic substitution reactions. .
Unit IV

Alcohols: *Preparation:* Preparation of 1o, 2o and 3o alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters.
Reactions: With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk. KMnO4, acidic dichromate, conc. HNO3), factors affecting acidity, Oppeneauer oxidation
Diols: oxidation of diols. Pinacol-Pinacolone rearrangement.
Phenols: (Phenol case) *Preparation:* Cumene hydroperoxide method, from diazonium salts. *Reactions:* Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer-Tiemann Reaction, Gattermann-Koch Reaction, Houben–Hoesch Condensation, Schotten – Baumann Reaction. acidity and factors affecting
Ethers (aliphatic and aromatic). Preparation : Williamson ether synthesis. **Reactions:** Cleavage of ethers with HI
Aldehydes and ketones (aliphatic and aromatic):
Preparation: from acid chlorides and from nitriles.

Reactions – Nucleophilic addition, Nucleophilic addition – elimination reaction including Reaction with HCN, ROH, NaHSO3, NH2-G derivatives. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemensen reduction and Wolff Kishner reduction. Meerwein-Pondorff Verley reduction.
Course Outcomes:
After the successful completion of the course the learner would be able to

i. Understand the basic concept of organic chemistry.
ii. Understand stereochemistry of organic compunds
iii. Understand mechanisms of organic reactions.

iv. Understand the methods of preparation and reaction of different functional groups in organic chemistry.

Reference Books:

- T. W. Graham Solomons: *Organic Chemistry*, *John Wiley and Sons*.
- Peter Sykes: *A Guide Book to Mechanism in Organic Chemistry*, Orient Longman.
- I.L. Finar: *Organic Chemistry* (Vol. I & II), E. L. B. S.
- R. T. Morrison & R. N. Boyd: *Organic Chemistry*, Prentice Hall.
- Arun Bahl and B. S. Bahl: *Advanced Organic Chemistry,* S. Chand.

Syllabus of B.Sc. (H) Physics

Semester IV

Discipline Core Course (DCC)

B.Sc.(H) Physics Sem-IV
Paper: Mathematical Physics-III
Paper Code: BPH-401

No. of Credits: 4	**Sessional: 25**
L: 4, T: 0	**Theory Exam: 75**
Theory: 60 Lectures	**Total: 100**

Course Objectives: *The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.*

Complex Analysis: Brief Revision of Complex Numbers and their Graphical Representation. Euler's formula, De Moivre's theorem, Roots of Complex Numbers. Functions of Complex Variables. Analyticity and Cauchy-Riemann Conditions. Examples of analytic functions. Singular functions: poles and branch points, order of singularity, branch cuts. (15 Lectures)

Integration of a function of a complex variable: Cauchy's Inequality. Cauchy's Integral formula. Simply and multiply connected region. Laurent and Taylor's expansion. Residues and Residue Theorem. Application in solving Definite Integrals. (15 Lectures)

Integrals Transforms: Fourier Transforms: Fourier Integral theorem. Fourier Transform. Examples. Fourier transform of trigonometric, Gaussian, finite wave train and other functions. Representation of Dirac delta function as a Fourier Integral. Fourier transform of derivatives, Inverse Fourier transform, Convolution theorem. Properties of Fourier transforms (translation, change of scale, complex conjugation, etc.). One dimensional Wave Equations, Dirac delta function, definition and properties. (15 Lectures)

Laplace Transforms: Laplace Transform (LT) of Elementary functions. Properties of LTs: Change of Scale Theorem, Shifting Theorem. LTs of 1st and 2nd order Derivatives and Integrals of Functions, Derivatives and Integrals of LTs. LT of Unit Step function, Dirac Delta function, Periodic Functions. Convolution Theorem. Inverse LT. Application of Laplace Transforms to 2nd order Differential Equations: Coupled differential equations of 1st order. Solution of heat flow along semi infinite bar using Laplace transform. (15 Lectures)

Course Outcomes: After the completion of the course, students will be able to,

- Know the concepts of complex numbers, function of complex variables and their singularities.
- Integrate the functions of complex variables
- Learn the Fourier transform techniques of various functions and associated theorems.
- Learn the Laplace transform techniques of various functions and associated theorems.

Reference Books:

Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press
Mathematics for Physicists, P.Dennery and A.Krzywicki, 1967, Dover Publications
Complex Variables, A.S.Fokas & M.J.Ablowitz, 8th Ed., 2011, Cambridge Univ. Press Complex Variables, A.K. Kapoor, 2014, Cambridge Univ. Press
Complex Variables and Applications, J.W.Brown & R.V.Churchill, 7th Ed. 2003, Tata McGraw-Hill

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B.Sc.(H) Physics Sem-IV
Paper: Mathematical Physics-III Lab
Paper Code: BPH-404

No. of Credits: 2	**Sessional: 15**
L: 0, P: 4	**External Exam: 35**
Lab: 60 Periods	**Total: 50**

C^{++}/Scilab based simulations experiments on Mathematical Physics problems like

1. Solve differential equations:

$dy/dx = e^{-x}$ with $y = 0$ for $x = 0$

$dy/dx + e^{-x}y = x^2$

$d^2y/dt^2 + 2\, dy/dt = -y$

$d^2y/dt^2 + e^{-t}dy/dt = -y$

2. Dirac Delta Function:

Evaluate $\frac{1}{\sqrt{2\pi\sigma^2}}\int e^{\frac{-(x-2)^2}{2\sigma^2}}(x+3)\,dx$, *for = 1, 0.1, 0.01 and show it tends to 5*

3. Fourier Series:

(i) Program to sum $\sum_{n=1}^{\infty}(0.2)^n$

(ii) Evaluate the Fourier coefficient of a given periodic function (square wave)

4. Frobenius method and special functions:

(i) $\int_{-1}^{+1} P_n(x).P_m(x)\,dx = \delta_{n,m}$

(ii) Plot $P_n(x)$ and $J_n(x)$

Show recursion relation

5. Calculation of error for each data point of observations recorded in experiments done in previous semesters (choose any two).

6. Calculation of least square fitting manually without giving weightage to error. Confirmation of least square fitting of data through computer program.

7. Evaluation of trigonometric functions e.g. *sin θ,* Given Bessel's function at N points find its value at an intermediate point. Complex analysis: Integrate $1/(x^2+2)$ numerically and check with computer integration.

8. Integral transform: FFT of e^{-x^2}

Reference Books:

- Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández. 2014 Springer ISBN: 978-3319067896
- A Guide to MATLAB, B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, 2014, 3rd Edn., Cambridge University Press
- Getting started with Matlab, Rudra Pratap, 2010, Oxford University Press.

B.Sc.(H) Physics Sem-IV
Paper: ELEMENTS OF MODERN PHYSICS
Paper Code: BPH-402

No. of Credits: 4	**Sessional: 25**
L: 4, T: 0	**Theory Exam: 75**
Theory: 60 Lectures	**Total: 100**

COURSE OBJECTIVE

The objective of the course is to get the students aware how the development in Modern Physics changed the Physics throughout.

Planck's quantum, Planck's constant and light as a collection of photons; Blackbody Radiation: Quantum theory of Light; Photo-electric effect and Compton scattering. De Broglie wavelength and matter waves; Davisson-Germer experiment. Wave description of particles by wave packets. Group and Phase velocities and relation between them. Two-Slit experiment with electrons. Probability. Wave amplitude and wave functions. (15 Lectures)

Position measurement- gamma ray microscope thought experiment; Wave-particle duality, Heisenberg uncertainty principle (Uncertainty relations involving Canonical pair of variables): Estimating minimum energy of a confined particle using uncertainty principle. (4 Lectures)

Two slit interference experiment with photons, atoms and particles; linear superposition principle as a consequence; Matter waves and wave amplitude; Schrodinger equation for non-relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of a wave function, probabilities and normalization; Probability and probability current densities in one dimension. (10 Lectures)

One dimensional infinitely rigid box- energy eigen values and eigen functions, normalization; Quantum dot as example; Quantum mechanical scattering and tunnelling in one dimension-across a step potential & rectangular potential barrier. (10 Lectures)

Size and structure of atomic nucleus and its relation with atomic weight; Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle. Nature of nuclear force, NZ graph, Liquid Drop model: semi-empirical mass formula and binding energy. (7 Lectures)

Radioactivity: stability of the nucleus; Law of radioactive decay; Mean life and half-life; Alpha decay; Beta decay- energy released, spectrum and Pauli's prediction of neutrino; Gamma ray emission, energy-momentum conservation: electron-positron pair creation by gamma photons in the vicinity of a nucleus. (9 Lectures)

Lasers: Metastable states. Spontaneous and Stimulated emissions. Einstein Coefficients, Optical Pumping and Population Inversion. Basic lasing. (5 Lectures)

Course Outcomes: After the completion of the course, students will be able to,

- Know the basic concepts od old Quantum theory
- Understand the interference and basics of the wave theory
- Learn the basic properties of nucleus and nuclear binding energy.
- Have an understanding of Nuclear radioactivity laws and basics of Lasers.

Reference Books:

- Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
- Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGraw Hill
- Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.
- Modern Physics, G.Kaur and G.R. Pickrell, 2014, McGraw Hill

B.Sc.(H) Physics Sem-IV
Paper: Modern Physics Lab
Paper Code: BPH-405

No. of Credits: 2
L: 0, P: 4
Lab: 60 Periods

Sessional: 15
External Exam: 35
Total: 50

At least 06 experiments from following:

1. Measurement of Planck's constant using black body radiation and photo-detector.
2. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light
3. To determine work function of material of filament of directly heated vacuum diode.
4. To determine the Planck's constant using LEDs of at least 4 different colours.
5. To determine the wavelength of H-alpha emission line of Hydrogen atom.
6. To determine the ionization potential of mercury.
7. To determine the absorption lines in the rotational spectrum of Iodine vapour.
8. To determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet.
9. To setup the Millikan oil drop apparatus and determine the charge of an electron.
10. To show the tunneling effect in tunnel diode using I-V characteristics.
11. To determine the wavelength of laser source using diffraction of single slit.
12. To determine the wavelength of laser source using diffraction of double slits.
13. To determine angular spread of He-Ne laser using plane diffraction grating

Reference Books

- Advanced Practical Physics for students, B.L. Flint and H.T.Worsnop, 1971, Asia Publishing House
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Edn, 2011,Kitab Mahal

B.Sc.(H) Physics Sem-IV
Paper: DIGITAL SYSTEMS AND APPLICATIONS
Paper Code: BPH-403

No. of Credits: 4	**Sessional: 25**
L: 4, T: 0	**Theory Exam: 75**
Theory: 60 Lectures	**Total: 100**

COURSE OBJECTIVE
The objective of the course is to get knowledge of the digital systems and their applications in technology.

Digital Circuits: Difference between Analog and Digital Circuits. Binary Numbers. Decimal to Binary and Binary to Decimal Conversion. BCD, Octal and Hexadecimal numbers. AND, OR and NOT Gates (realization using Diodes and Transistor). NAND and NOR Gates as Universal Gates. XOR and XNOR Gates and application as Parity Checkers. (6 Lectures)

Boolean algebra: De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Algebra. Idea of Minterms and Maxterms. Conversion of Truth table into Equivalent Logic Circuit by (1) Sum of Products (SOP), Product of Sum (POS) Method and (2) Karnaugh Map. (8 Lectures)

Data processing circuits: Multiplexers, De-multiplexers, Decoders, Encoders. (4 Lectures)

Arithmetic Circuits: Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders. Half & Full Subtractors, 4-bit binary Adder/Subtractor. (4 Lectures)

Sequential Circuits: SR, D, T and JK Flip-Flops. Clocked (Level and Edge Triggered) Flip-Flops. Preset and Clear operations. Race-around conditions in JK Flip-Flop. M/S JK Flip-Flop. (6 Lectures)

Shift registers: Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel-in-Parallel-out Shift Registers (only up to 4 bits). (4 Lectures)

Counters(4 bits): Ring Counter. Asynchronous counters, Decade Counter. Synchronous Counter. (4 Lectures)

Timers: IC 555: block diagram and applications: Astable multivibrator and Monostable multivibrator. (4 Lectures)

Integrated Circuits (Qualitative treatment only): Active and Passive components. Discrete components. Wafer. Chip. Advantages and drawbacks of ICs. Scale of integration: SSI, MSI, LSI and VLSI (basic idea and definitions only). Classification of ICs. Examples of Linear and Digital lCs. (3 Lectures)

Memory Organization: Data storage (idea of RAM and ROM). Computer memory. Memory organization and addressing. Memory Map. (3 Lectures)

Intel 8085 Microprocessor Architecture: Main features of 8085. Block diagram. Components. Pin-out diagram. Buses. Registers. ALU. Memory. Stack memory. Timing and Control circuitry. Timing states. Instruction cycle, Timing diagram of MOV and MVI. (10 Lectures)

Introduction to Assembly Language:1 byte, 2 byte and 3 byte instructions. (4 Lectures)

Course Outcomes: After the completion of the course, students will be able to,

- Know the basic digital circuits and Boolean algebra.
- Understand the circuitry, working and applications of data processing circuits and arithmetic circuits.
- Learn the working and applications of sequential circuits shift registers, counters and their applications.
- Have a basic knowledge of ICs, Timer ICs and Memory ICs.
- Learn the basics of microprocessor and assembly Language.

Reference Books:

- Digital Principles and Applications, A.P.Malvino, D.P. Leach and Saha, 7th Ed., 2011, Tata McGraw
- Fundamentals of Digital Circuits, Anand Kumar, 2nd Edn, 2009, PHI Learning Pvt. Ltd.
- Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
- Digital Electronics G K Kharate ,2010, Oxford University Press Logic circuit design, Shimon P. Vingron, 2012, Springer.
- Microprocessor Architecture Programming & applications with 8085, 2002, R.S. Goankar, Prentice Hall.

B.Sc.(H) Physics Sem-IV
Paper: Digital Systems & Applications Lab
Paper Code: BPH-406

No. of Credits: 2	**Sessional: 15**
L: 0, P: 4	**External Exam: 35**
Lab: 60 Periods	**Total: 50**

At least 06 experiments each from section A and Section B Section-A: Digital Circuits Hardware design/Verilog Design

1. To design a combinational logic system for a specified Truth Table.
    (b) To convert Boolean expression into logic circuit & design it using logic gate ICs.
    (c) To minimize a given logic circuit.
2. Half Adder, Full Adder and 4-bit binary Adder.

3. Half Subtractor, Full Subtractor, Adder-Subtractor using Full Adder I.C.
4. To build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates.
5. To build JK Master-slave flip-flop using Flip-Flop ICs
6. To build a 4-bit Counter using D-type/JK Flip-Flop ICs and study timing diagram.
7. To make a 4-bit Shift Register (serial and parallel) using D-type/JK Flip-Flop ICs.
8. To design an astable multivibrator of given specifications using 555 Timer.
9. To design a monostable multivibrator of given specifications using 555 Timer.

Section-B: Programs using 8085 Microprocessor:

1. Addition and subtraction of numbers using direct addressing mode
2. Addition and subtraction of numbers using indirect addressing mode
3. Multiplication by repeated addition.
4. Division by repeated subtraction.
5. Handling of 16-bit Numbers.
6. Use of CALL and RETURN Instruction.
7. Block data handling.
8. Other programs (e.g. Parity Check, using interrupts, etc.).

Reference Books:

Modern Digital Electronics, R.P. Jain, 4th Edition, 2010, Tata McGraw Hill.
Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.
Microprocessor Architecture Programming and applications with 8085, R.S. Goankar, 2002, Prentice Hall.
Microprocessor 8085:Architecture, Programming and interfacing, A.Wadhwa, 2010, PHI Learning.

Open Elective Courses (OEC)

Semester-IV

Open Elective Chemistry

Paper: Spectroscopy

Paper Code: OCHE-401

Credits: 04

		SESSIONAL:	25
L	T	THEORY EXAM:	75
4	0	TOTAL:	100

Course Objectives: To learn and understand the basic concepts of spectroscopy.

Unit I

Spectroscopy;

Introduction, Electromagnetic radiation, regions of spectrum, basic features of spectroscopy, statement of Born-oppenheimer approximation, Degrees of freedom.

Rotational Spectrum

Selection rules, Energy levels of rigid rotator (semi-classical principles), rotational spectra of diatomic molecules , spectral intensity distribution using population distribution (Maxwell-Boltzmann distribution), determination of bond length and isotopic effect .

Unit II

Ultraviolet (UV) absorption spectroscopy

Absorption laws (Beer-Lambert law), molar absorptivity, presentation and analysis of UV spectra, types of electronic transitions, effect of conjugation. Concept of chromophore and auxochrome. Bathochromic, hypsochromic, hyperchromic and hypochromic shifts. UV spectra of conjugated enes and enones,Woodward- Fieser rules, calculation of λm a x of simple conjugated dienes and α,β -unsaturated ketones. Applications of UV Spectroscopy in structure elucidation of simpl e

Unit III

Vibrational spectrum

Infrared (IR) absorption spectroscopy Molecular vibrations, Hooke's law, selection rules, intensity and position of IR bands, measurement of IR spectrum, fingerprint region, characteristic absorptions of various functional groups and interpretation of IR spectra of simple organic compounds. Applications of IR spectroscopy in structure elucidation of simple organic compounds

Raman Spectrum

Concept of polarizibility, pure rotational and pure vibrational Raman spectra of diatomic molecules, selection rules, Quantum theory of Raman spectra.

Unit IV

NMR Spectroscopy

Principle of nuclear magnetic resonance, the PMR spectrum,number of signals, peak areas, equivalent and nonequivalent protons positions of signals and chemical shift,shielding and deshielding of protons, proton counting,splitting of signals and coupling constants, magnetic equivalence of protons.Discussion of PMR spectra of the molecules: ethyl bromide, n-propyl bromide, isopropyl bromide, 1,1-dibromoethane, ethanol, acetaldehyde, ethyl acetate, toluene, benzaldehyde and acetophenone.

Simple problems on PMR spectroscopy for structure determination of organic compounds.

Course Outcomes:

After the successful completion of the course the learner would be able to

i. Understand the basic concept of spectroscopy and rotational spectroscopy.
ii. Understand the concept of UV-Visible spectroscopy
iii. Understand the concept of IR spectroscopy
iv. Understand the concept of NMR spectroscopy and structure elucidation problems using spectral data.

Understand the role of inorganic chemistry in biological systems

Books Suggested

1. Introduction to Spectroscopy- A Guide for Students of Organic Chemistry, 2nd Edn. By Donald L. Pavia, Gary M. Lampman and George S. Kriz. Saunders Golden Sunburst Series. Harcourt Brace College Publishers, New York.
2. Spectrometric Identification of Organic Compounds, R. M. Silverstein, G. C. Bassler and T. C. Morrill, John Wiley.
3. Application of Spectroscopy of Organic Compounds, J. R. Dyer, Prentice Hall.
4. Spectroscopic Methods in Organic Chemistry, D. H. Williams and I. Fleming, Tata McGraw-Hill.
5. Spectroscopy of Organic Compounds by P.S. Kalsi, Wiley Estern, New Delhi.
6. Organic Spectgroscopy by William Kemp, John Wiley.
7. Organic Mass Spectrometry by K.G. Das & E.P. James, Oxford & IBH Publishing Co.
8. Organic Spectroscopy (Principles & Applications) by Jagmohan.

Semester-IV
Open Elective Electronics
Paper: Microprocessor and Microcontroller System
Paper Code: OELC 401

Credits: 04

L	T			
			SESSIONAL:	25
			THEORY EXAM:	75
4	0		TOTAL:	100

Total Lectures 60

Unit-1 (15 Lectures)

Number systems: Binary, hexadecimal – conversion from binary to decimal and vice-versa, binary to hexadecimal and vice-versa, decimal to hexadecimal and vice versa, addition and subtraction of binary numbers and hexadecimal numbers. Subtraction using 2‘s complement, signed number arithmetic.

Introduction to Microprocessor: Introduction, applications, basic block diagram, speed, word size, memory capacity, classification of microprocessors (mention different microprocessors being used)

Microprocessor 8085: Features, architecture -block diagram, internal registers, register pairs, flags, stack pointer, program counter, types of buses. Multiplexed address and data bus, generation of control signals, pin description of microprocessor 8085.

Unit-2 (15 Lectures)
8085 Instructions: Operation code, Operand & Mnemonics.
Instruction set of 8085, instruction classification, addressing modes, instruction format.
Data transfer instructions, arithmetic instructions, increment & decrement instructions, logical instructions, branch instructions and machine control instructions.
Stack operations, subroutine calls and return operations. Delay loops, use of counters, timing diagrams-instruction cycle, machine cycle, T- states, time delay

Unit-3 (13 Lectures)
Interrupt structure of 8085A microprocessor, processing of vectored and non-vectored interrupts, latency time and response time
Interfacing of memory chips, address allocation technique and decoding; Interfacing of I/O devices, LEDs and toggle-switches as examples, memory mapped and isolated I/O structure; Input/output techniques: CPU initiated unconditional and conditional I/O transfer.

Unit- 4 (17 Lectures)
Introduction to Microcontrollers: Basic block diagram, comparison of microcontroller with microprocessors, comparison of 8 bit, 16 bit and 32 bit microcontrollers.
MICROCONTROLLER 8051- architecture **-**internal block diagram, key features of 8051, pin diagram, memory organization, Internal RAM memory, Internal ROM. General purpose data memory, special purpose/function registers, external memory.
Counters and timers: 8051 oscillator and clock, program counter, TCON, TMOD, timer counter interrupts, timer modes of operation. Input / output ports and circuits/ configurations, serial data input / output – SCON, PCON, serial data transmission modes.

Course Outcomes: After the completion of the course, students will be able to,

- Know the number system and basics of microprocessor 8085
- Learn the basic programming instructions of 8085 μ-P.
- Learn the interfacing of various I/O devices.
- Have a basic knowledge of Microcontroller, counters and timers.

Suggested Books:

1. Microprocessor Architecture, Programming and Applications with 8085, Ramesh S.Gaonkar - Wiley Eastern Limited- IV Edition.
2. Fundamentals of Microprocessor & Microcomputer: B. Ram— Danpat Rai Publications.
3. Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D. MCKinlay ―The 8051 Microcontroller and Embedded Systems‖, 2nd Edition, Pearson Education 2008.

Semester-IV

Paper: Microprocessor and Microcontroller System Lab

Paper code: OELC-402

Credits: 02			**SESSIONAL:**	**15**
L	P		THEORY EXAM:	35
0	4		TOTAL:	50

Practical: 60 lectures

1. Program to transfer a block of data.
2. Program for multibyte addition
3. Program for multibyte subtraction
4. Program to multiply two 8-bit numbers.
5. Program to divide a 16 bit number by 8 bit number.
6. Program to search a given number in a given list.
7. Program to generate terms of Fibonacci series.
8. Program to sort numbers in ascending/descending order.
9. Program to find the square root of an integer.
10. To study interfacing of IC 8255.
11. Program to verify the truth table of logic gates.

Semester-IV
Open Elective Mathematics
Paper: NUMERICAL METHODS
Paper Code: OMTH-401

Credits: 06

			SESSIONAL:	25
L	T		THEORY EXAM:	75
5	1		TOTAL:	100

Theory: 75 lecture

COURSE OBJECTIVES

The main objective of this course is to give the solutions of applied problems and it helps students to have an in-depth knowledge of various advanced methods in numerical analysis.

UNIT-I

Floating point representation and computer arithmetic, Significant digits, Errors: Roundoff error, Local truncation error, Global truncation error, Order of a method, Convergence and terminal conditions, Solution of algebraic and transcendental equations: Bisection method, method of false position,secant method, iteration method, Newton's Raphson method, Generalised Newton-Raphson method.

UNIT-II

Various difference operators and relation between them .Newton‘s forward and backward interpolation formulae. Central difference interpolation formula. Gauss forward and backward interpolation formulae. Langrange’s interpolation formula and Newton‘s divided difference formulae.

UNIT-III

Solution of simultaneous algebraic equations: Jacobi's method, Gauss-Seidal method, Relaxation method.

Numerical differentiation and integration: Formula for derivatives, Trapezoidal rule, Simpson's 1/3rd and 3/8th rules, Boole's rule and Weddle's rule, Romberg's Integration.

UNIT-IV

Numerical solution of O.D.E.: Taylor series, Picard‘s method, Euler’s Method, Modified Euler method, Runge-Kutta second and fourth order methods, predictor collector methods(Adams-Bashforth and Milne's method only).

COURSE OUTCOMES

After completing this course satisfactorily, a student will be able to:

- Understand about the solution of algebraic equations, transcendental equations and simultaneous algebraic equations.
- Understand about Newton‘s forward and backward interpolation formulae, Central difference interpolation formula, Gauss forward and backward interpolation formulae, Langranges interpolation formula and Newton‘s divided difference formulae.
- Understand about the solution of Trapezoidal rule, Simpson's 1/3rd and 3/8th rules, Boole's rule and Weddle's rule, Romberg's Integration
- Understand about the numerical solution of ODE and PDE

REFERENCES BOOKS

1. K. Atkinson and W. Han, Elementary Numerical Analysis, John Wiley,2006.
2. Numerical Methods in Engg. &Science : B.S. Grewal :khanna publications.
3. Numerical Methods for Scientific and Engg. Computations : M.K. Jain, S.R.K. Iyengerand R.K. Jain-Wiley Eastern Ltd
4. Taneja, H.C. "Advanced Engineering Mathematics", IK International, New Delhi.
5. Introductory Methods of Numerical Analysis: S.S. Shastri, PHI learning pvt limited.

Semester-IV
Open Elective Computer Science
Paper: Information Security
Paper Code: OCSC-401

Credits: 04

L	T	SESSIONAL:	25
		THEORY EXAM:	75
4	0	TOTAL:	100

Theory: 60 lecture

Course Objectives:

1. To study goals of security and ethical issues related to the misuse of computer security.
2. Understand the basic concept of Cryptography and Network Security, their mathematical models.
3. To understand various types of ciphers, DES, AES, message Authentication, digital Signature System.
4. To get knowledge about network security, virus, worms and firewall and Acquire knowledge in security issues, services, goals and mechanism
5. Understand the SSL or firewall based solution against security threats.

Course Introduction: Computer network as a threat, hardware vulnerability, software vulnerability, importance of data security.

Digital Crime: Overview of digital crime, criminology of computer crime.

Information Gathering Techniques: Tools of the attacker, information and cyber warfare, scanning and spoofing, password cracking, malicious software, session hijacking

Risk Analysis and Threat: Risk analysis, process, key principles of conventional computer security, security policies, authentication, data protection, access control, internal vs external threat, security assurance, passwords, authentication, and access control, computer forensics and incident response

Introduction to Cryptography and Applications : Important terms, Threat, Flaw, Vulnerability, Exploit, Attack, Ciphers, Codes, Caeser Cipher, Rail-Fence Cipher, Public key cryptography (Definitions only), Private key cryptography (Definition and Example), Digital Certificates

Safety Tools and Issues : Firewalls, logging and intrusion detection systems, Windows and windows XP / NT security, Unix/Linux security, ethics of hacking and cracking

Course Outcomes:

After the completion of this course the student will able to:

1. Understand theory of fundamental cryptography, encryption and decryption algorithms,
2. Build secure authentication systems by use of message authentication techniques.
3. Understand a given ciphering algorithm and to analyze it.

4. Apply the crypto systems so far learned to building of information and network security mechanisms.

Reference Books:

1. M. Merkow, J. Breithaupt, Information Security Principles and Practices, Pearson Education.2005
2. G.R.F. Snyder, T. Pardoe, Network Security, Cengage Learning, 2010
3. A. Basta, W.Halton, Computer Security: Concepts, Issues and Implementation, Cengage Learning India, 2008

Semester-IV

Paper: Information Security Lab

Paper code: OCSC-402

Credits: 02		**SESSIONAL:**	**15**
L	P	THEORY EXAM:	35
0	4	TOTAL:	50

Practical: 60 lectures

1. Demonstrate the use of Network tools: ping, ipconfig, ifconfig, tracert, arp, netstat, whois
2. Use of Password cracking tools : John the Ripper, Ophcrack. Verify the strength of passwords using these tools.
3. Perform encryption and decryption of Caesar cipher. Write a script for performing these operations.
4. Perform encryption and decryption of a Rail fence cipher. Write a script for performing these operations.
5. Use nmap/zenmap to analyse a remote machine.
6. Use Burp proxy to capture and modify the message.
7. Demonstrate sending of a protected word document.
8. Demonstrate sending of a digitally signed document.
9. Demonstrate sending of a protected worksheet.
10. Demonstrate use of steganography tools.
11. Demonstrate use of gpg utility for signing and encrypting purposes.

Skill Enhancement Course in Physics (SECP)

Common for Semester- III & IV

(Choose any one SEC course and respective lab in each semester (III & IV)

B.Sc.(H) Physics
Paper: Computational Physics Skills
Paper Code: SECP-01

No. of Credits: 2	**Sessional: 25**
L: 2, T: 0	**Theory Exam: 75**
Theory: 30 Lectures	**Total: 100**

Course Objective: *The aim of this course is not just to teach computer programming and numerical analysis but to emphasize its role in solving problems in Physics and Science. Highlights the use of computational methods to solve physical problems Use of computer language as a tool in solving physics/science problems*

Course will consist of hands on training on the Problem solving on Computers.

Introduction: Usage of linux as an Editor. Algorithms and Flowcharts: Algorithm: Definition, properties and development. Flowchart: Concept of flowchart, symbols, guidelines, types. Examples: Roots of Quadratic Equation, Sum of two matrices, Sum and Product of a finite series, calculation of sin(x) as a series. (4 Lectures)

Scientific Programming: Some fundamental Linux Commands (Internal and External commands). Development of FORTRAN, Basic elements of FORTRAN: Character Set, Constants and their types, Variables and their types, Keywords, Variable Declaration and concept of instruction and program. Operators: Arithmetic, Relational, Logical and Assignment Operators. Expressions: Arithmetic, Relational, Logical, Character and Assignment Expressions. Fortran Statements: I/O Statements (unformatted/formatted), Executable and Non-Executable Statements, Layout of Fortran Program, Format of writing Program and concept of coding, Initialization and Replacement Logic. Examples from physics problems. (8 Lectures)

Control Statements: Types of Logic (Sequential, Selection, Repetition), Branching Statements (Logical IF, Arithmetic IF, Block IF, Nested Block IF, SELECT CASE and ELSE IF Ladder statements), Looping Statements (DO-CONTINUE, DO-ENDDO, DO-WHILE, Implied and Nested DO Loops), Jumping Statements (Unconditional GOTO, Computed GOTO, Assigned GOTO) Subscripted Variables (Arrays: Types of Arrays, DIMENSION Statement, Reading and Writing Arrays), Functions and Subroutines (Arithmetic Statement Function, Function Subprogram and Subroutine), RETURN, CALL, COMMON and EQUIVALENCE Statements), Structure, Disk

I/O Statements, open a file, writing in a file, reading from a file. Examples from physics problems. (12 Lectures)

Visualization: Introduction to graphical analysis and its limitations. Introduction to Gnuplot. basic Gnuplot commands: simple plots, plotting data from a file, saving and exporting, physics with Gnuplot (equations, building functions, user defined variables and functions), Understanding data with Gnuplot (6 Lectures)

Course Outcomes: After the completion of the course, students will be able to,

- Know the basics of Linux, algorithm and flowcharts.
- Learn the FORTRAN programming language.
- Learn various controlling and looping statements in FORTRAN.
- Have a basic understanding of the physics of gnuplots.

Reference Books:

- Introduction to Numerical Analysis, S.S. Sastry, 5th Edn., 2012, PHI Learning Pvt. Ltd.
- Computer Programming in Fortran 77". V. Rajaraman (Publisher:PHI).
- Gnuplot in action: understanding data with graphs, Philip K Janert, (Manning 2010)
- Schaum's Outline of Theory and Problems of Programming with Fortran, S Lipsdutz and A Poe, 1986Mc-Graw Hill Book Co.
- Computational Physics: An Introduction, R. C. Verma, etal. New Age International Publishers, New Delhi(1999)
- Elementary Numerical Analysis, K.E.Atkinson,3rd Edn . , 2 007 , Wiley India Edition.

B.Sc.(H) Physics
Paper: Computational Physics Skills Lab
Paper Code: SECP-04

No. of Credits: 0	**Sessional: 15**
L: 0, P: 2	**Theory Exam: 35**
Theory: 30 Lectures	**Total: 50**

Programming:

1. Exercises on syntax on usage of FORTRAN
2. Usage of GUI Windows, Linux Commands, familiarity with DOS commands and working in an editor to write sources codes in FORTRAN.
3. To print out all natural even/ odd numbers between given limits.
4. To find maximum, minimum and range of a given set of numbers.
5. Calculating Euler number using exp(x) series evaluated at x=1 (6 Lectures)

Hands on exercises:

1. To compile a frequency distribution and evaluate mean, standard deviation etc.
2. To evaluate sum of finite series and the area under a curve.
3. To find the product of two matrices
4. To find a set of prime numbers and Fibonacci series.
5. To write program to open a file and generate data for plotting using Gnuplot.
6. Plotting trajectory of a projectile projected horizontally.
7. Plotting trajectory of a projectile projected making an angle with the horizontally.
8. Creating an input Gnuplot file for plotting a data and saving the output for seeing on the screen. Saving it as an eps file and as a pdf file.
9. To find the roots of a quadratic equation.
10. Motion of a projectile using simulation and plot the output for visualization.
11. Numerical solution of equation of motion of simple harmonic oscillator and plot the outputs for visualization.
12. Motion of particle in a central force field and plot the output for visualization. (9 Lectures)

Reference Books:

- Introduction to Numerical Analysis, S.S. Sastry, 5th Edn., 2012, PHI Learning Pvt. Ltd.
- Computer Programming in Fortran 77". V. Rajaraman (Publisher:PHI).
- Gnuplot in action: understanding data with graphs, Philip K Janert, (Manning 2010)
- Schaum's Outline of Theory and Problems of Programming with Fortran, S Lipsdutz and A Poe, 1986Mc-Graw Hill Book Co.
- Computational Physics: An Introduction, R. C. Verma, etal. New Age International Publishers, New Delhi(1999)
- Elementary Numerical Analysis, K.E.Atkinson,3 rd Edn . , 2 007 , Wiley India Edition.

B.Sc.(H) Physics
Paper: ELECTRICAL CIRCUITS AND NETWORK SKILLS
Paper Code: SECP-02

No. of Credits: 2	**Sessional: 25**
L: 2, T: 0	**Theory Exam: 75**
Theory: 30 Lectures	**Total: 100**

Course Objectives: *The aim of this course is to enable the students to design and trouble shoots the electrical circuits, networks and appliances through hands-on mode.*

Basic Electricity Principles: Voltage, Current, Resistance, and Power. Ohm's law. Series, parallel, and series-parallel combinations. AC and DC Electricity. Familiarization with multimeter, voltmeter and ammeter. (3 Lectures)

Electrical Circuits: Basic electric circuit elements and their combination. Rules to analyze DC sourced electrical circuits. Single-phase and three-phase alternating current sources. Rules to analyze AC sourced electrical circuits. Real, imaginary and complex power components of AC source. Power factor. Saving energy and money. (5 Lectures)

Generators and Transformers: DC Power sources. AC/DC generators. Inductance, capacitance, and impedance. Operation of transformers. (4 Lectures)

Electric Motors: Single-phase, three-phase & DC motors. Basic design. Interfacing DC or AC sources to control heaters and motors. Speed & power of ac motor. (5Lectures)

Solid-State Devices: Resistors, inductors and capacitors. Components in Series or in shunt. Response of inductors and capacitors with DC or AC sources (2 Lectures)

Electrical Protection: Relays. Fuses and disconnect switches. Circuit breakers. Overload devices. Ground-fault protection. Grounding and isolating. Phase reversal. Surge protection. Relay protection device. (7 Lectures)

Electrical Wiring: Basics of wiring-Star and delta connection. Voltage drop and losses across cables and conductors. Insulation. Solid and stranded cable. Preparation of extension board. (4 Lectures)

Course Outcomes: After the completion of the course, students will be able to,

- Know the basic electrical circuits and their working principles
- Understand of working theory of Generators/Transformers and AC and DC motors.
- Learn the various passive components and their connections.
- Have an understanding of electrical wiring and electrical protection techniques.

Reference Books:

- Electrical Circuits, K.A. Smith and R.E. Alley, 2014, Cambridge University Press A text book in Electrical Technology - B L Theraja - S Chand & Co.
- A text book of Electrical Technology - A K Theraja
- Performance and design of AC machines - M G Say ELBS Edn.

B.Sc.(H) Physics
Paper: ELECTRICAL CIRCUITS AND NETWORK SKILLS Lab
Paper Code: SECP-05

No. of Credits: 0	**Sessional: 15**
L: 0, P: 2	**Theory Exam: 35**
Theory: 30 Lectures	**Total: 50**

Course Objective: *The aim of this lab course is to enable the students to design and trouble shoots the electrical circuits, networks and appliances through hands-on mode*

1. Use of multimeter to measure AC and DC Voltage and Current, Resistance, and Power.
2. Series, parallel, and series-parallel combinations

3. Ohm's law. Series, parallel, and series-parallel combinations.
4. DC Power sources. AC/DC generators. Inductance, capacitance, and impedance. Operation of transformers.
5. Resistors, inductors and capacitors. Diode, rectifiers and filters. Components in Series or in shunt.
6. Response of inductors and capacitors with DC or AC sources
7. Basics of wiring-Star and delta connection.
8. Preparation of extension board.

Reference Books:

- Electrical Circuits, K.A. Smith and R.E. Alley, 2014, Cambridge University Press
- A text book in Electrical Technology - B L Theraja - S Chand & Co.
- A text book of Electrical Technology - A K Theraja
- Performance and design of AC machines - M G Say ELBS Edn.

B.Sc.(H) Physics
Paper: BASIC INSTRUMENTATION SKILLS
Paper Code: SECP-03

No. of Credits: 2	**Sessional: 25**
L: 2, T: 0	**Theory Exam: 75**
Theory: 30 Lectures	**Total: 100**

Course Objective: *This course is to get exposure with various aspects of instruments and their usage through hands-on mode. Experiments listed below are to be done in continuation of the topics.*

Basic of Measurement: Instruments accuracy, precision, sensitivity, resolution range etc. Errors in measurements and loading effects. Multimeter: Principles of measurement of dc voltage and dc current, ac voltage, ac current and resistance. Specifications of a multimeter and their significance. (5 Lectures)

Electronic Voltmeter: Advantage over conventional multimeter for voltage measurement with respect to input impedance and sensitivity. Principles of voltage, measurement (block diagram only). Specifications of an electronic Voltmeter/ Multimeter and their significance. AC millivoltmeter: Type of AC millivoltmeters. Block diagram ac millivoltmeter, specifications and their significance. (5 Lectures)

Oscilloscope: Block diagram of basic CRO. CRT, electrostatic focusing and acceleration (Explanation only– no mathematical treatment), brief discussion on screen phosphor, visual persistence. Time base operation, synchronization. Front panel controls. Specifications of CRO and their significance. (6 Lectures)

Use of CRO for the measurement of voltage (dc and ac), frequency and time period. Special features of dual trace, introduction to digital oscilloscope, probes. Digital storage Oscilloscope: principle of working. (4 Lectures)

Impedance Bridges: Block diagram of bridge. working principles of basic (balancing type) RLC bridge. Specifications of RLC bridge. Block diagram and working principles of a Q- Meter. (3 Lectures)

Digital Instruments: Comparison of analog & digital instruments. Characteristics of a digital meter. Working principles of digital voltmeter. (3 Lectures)

Digital Multimeter: Block diagram and working of a digital multimeter. Working principle of time interval, frequency and period measurement using universal counter/ frequency counter, time- base stability, accuracy and resolution. (4 Lectures)

Course Outcomes: After the completion of the course, students will be able to,

- Know the basics of measurements, errors, use of multimeter.
- Learn the use of electronic voltmeter to measure AC and DC quantities.
- Understand the working theory and applications of CRO for measurements.
- Have an understanding of digital measuring tools and techniques.

Reference Books:

- A text book in Electrical Technology - B L Theraja - S Chand and Co. Performance and design of AC machines - M G Say ELBS Edn.
- Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill. Logic circuit design, Shimon P. Vingron, 2012, Springer.
- Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
- Electronic Devices and circuits, S. Salivahanan & N. S.Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill

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B.Sc.(H) Physics
Paper: BASIC INSTRUMENTATION SKILLS Lab
Paper Code: SECP-06

No. of Credits: 0	**Sessional: 15**
L: 0, P: 2	**Theory Exam: 35**
Theory: 30 Lectures	**Total: 50**

The test of lab skills will be of the following test items:

1. Use of an oscilloscope.
2. Oscilloscope as a versatile measuring device.
3. Circuit tracing of Laboratory electronic equipment,
4. Use of Digital multimeter/VTVM for measuring voltages
5. Circuit tracing of Laboratory electronic equipment,
6. Winding a coil / transformer.
7. Study the layout of receiver circuit.
8. Trouble shooting a circuit
9. Balancing of bridges

Laboratory Exercises:

1. To observe the loading effect of a multimeter while measuring voltage across a low resistance and high resistance.
2. To observe the limitations of a multimeter for measuring high frequency voltage and currents.
3. To measure Q of a coil and its dependence on frequency, using a Q- meter.
4. Measurement of voltage, frequency, time period and phase using Oscilloscope.
5. Measurement of time period, frequency, average period using universal counter/ frequency counter.
6. Measurement of rise, fall and delay times using a Oscilloscope.
7. Measurement of distortion of a RF signal generator using distortion factor meter.
8. Measurement of R,L and C using a LCR bridge/ universal bridge.

Open Ended Experiments:

1. Using a Dual Trace Oscilloscope
2. Converting the range of a given measuring instrument (voltmeter, ammeter)

Reference Books:

- A text book in Electrical Technology - B L Theraja - S Chand and Co. Performance and design of AC machines - M G Say ELBS Edn.
- Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill. Logic circuit design, Shimon P. Vingron, 2012, Springer.
- Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
- Electronic Devices and circuits, S. Salivahanan & N. S.Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill

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Syllabus of B.Sc. (H) Physics

Semester V

Discipline Core Course (DCC)

B.Sc.(H) Physics Sem-V
Paper: QUANTUM MECHANICS AND APPLICATIONS
Paper Code: BPH-501

No. of Credits: 4 | **Sessional: 25**
L: 4, T: 0 | **Theory Exam: 75**
Theory: 60 Lectures | **Total: 100**

Course Objectives: In continuation with modern physics this course is an application of Schrodinger equation to various quantum mechanical problems. This gives fair idea of formulation of eigenvalues and eigen functions.

Time dependent Schrodinger equation: Time dependent Schrodinger equation and dynamical evolution of a quantum state; Properties of Wave Function. Interpretation of Wave Function Probability and probability current densities in three dimensions; Conditions for Physical Acceptability of Wave Functions. Normalization. Linearity and Superposition Principles. Eigenvalues and Eigenfunctions. Position, momentum and Energy operators; commutator of position and momentum operators; Expectation values of position and momentum. Wave Function of a Free Particle. **(15 Lectures)**

Time independent Schrodinger equation-Hamiltonian, stationary states and energy eigen values; expansion of an arbitrary wave function as a linear combination of energy eigen functions; General solution of the time dependent Schrodinger equation in terms of linear combinations of stationary states; Application to spread of Gaussian wave-packet for a free particle in one dimension; wave packets, Fourier transforms and momentum space wave function; Position-momentum uncertainty principle. **(15 Lectures)**

General discussion of bound states in an arbitrary potential- continuity of wave function, boundary condition and emergence of discrete energy levels; application to one-dimensional problem-square well potential; potential barrier, reflection and refraction; Quantum mechanics of simple harmonic oscillator-energy levels and energy eigen functions using Frobenius method; Hermite polynomials; ground state, zero point energy & uncertainty principle. **(15 Lectures)**

Quantum theory of hydrogen-like atoms and Angular momentum: time independent Schrodinger equation in spherical polar coordinates; separation of variables for second order partial differential equation; angular momentum operator & quantum numbers; Radial wavefunctions from

Frobenius method; shapes of the probability densities for ground and first excited states; Orbital angular momentum quantum numbers l and m; s, p, d shells. Electron angular momentum. Angular momentum quantization. Electron Spin and Spin Angular Momentum. Total angular momentum. Pauli spin matrices and their properties. **(15 Lectures)**

COURSE OUTCOME

On successful completion of this course, students should be able to:

- Understand the time dependent Schrodinger equation and its applications.
- Understand the time independent Schrodinger equation and its applications.
- Apply their knowledge of quantum mechanics to study bound states potentials.
- Understand the theory of Angular Momentum and its application in quantum mechanics.

Reference Books:

- A Text book of Quantum Mechanics, P.M.Mathews and K.Venkatesan, 2^{nd} Ed., 2010, McGraw Hill
- Quantum Mechanics, Robert Eisberg and Robert Resnick, 2^{nd} Edn., 2002, Wiley.
- Quantum Mechanics, Leonard I. Schiff, 3^{rd} Edn. 2010, Tata McGraw Hill.
- Quantum Mechanics for Scientists & Engineers, D.A.B. Miller, 2008, Cambridge University Press
- Quantum Mechanics, Eugen Merzbacher, 2004, John Wiley and Sons, Inc.
- Introduction to Quantum Mechanics, D.J. Griffith, 2^{nd} Ed. 2005, Pearson Education

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B.Sc.(H) Physics Sem-V
Paper: QUANTUM MECHANICS AND APPLICATIONS Lab
Paper Code: BPH-503

No. of Credits: 2	**Sessional: 15**
L: 0, P: 4	**External Exam: 35**
Lab: 60 Periods	**Total: 50**

Use C/C^{++}/Scilab for solving the following problems based on Quantum Mechanics like

1. Solve the s-wave Schrodinger equation for the ground state and the first excited state of the hydrogen atom:

$$\frac{d^2y}{dr^2} = A(r).u(r), \quad A(r) = \frac{2m}{\hbar^2}[V(r) - E] \text{ where } V(r) = -\frac{e^2}{r}$$

Here, m is the reduced mass of the electron. Obtain the energy eigenvalues and plot the corresponding wave functions. Remember that the ground state energy of the hydrogen atom is approximately -13.6 eV. Take e = 3.795 $(eVÅ)^{1/2}$, ħc = 1973 (eVÅ) and m = 0.511×10^6 eV/c^2.

2. Solve the s-wave radial Schrodinger equation for an atom:

$$\frac{d^2y}{dr^2} = A(r).u(r), \quad A(r) = \frac{2m}{\hbar^2}[V(r) - E]$$

where m is the reduced mass of the system (which can be chosen to be the mass of an electron), for the screened coulomb potential

$$V(r) = -\frac{e^2}{r} e^{-r/a}$$

Find the energy (in eV) of the ground state of the atom to an accuracy of three significant digits. Also, plot the corresponding wave function. Take e = 3.795 $(eVÅ)^{1/2}$, m = 0.511x10^6 eV/c^2, and a = 3 Å, 5 Å, 7 Å. In these units ħc = 1973 (eVÅ). The ground state energy is expected to be above -12 eV in all three cases.

3. Solve the s-wave radial Schrodinger equation for a particle of mass m:

$$\frac{d^2y}{dr^2} = A(r).u(r), \quad A(r) = \frac{2m}{\hbar^2}[V(r) - E]$$

For the anharmonic oscillator potential

$$V(r) = \frac{1}{2}kr^2 + \frac{1}{3}br^3$$

for the ground state energy (in MeV) of particle to an accuracy of three significant digits. Also, plot the corresponding wave function. Choose m = 940 MeV/c^2, k = 100 MeV fm^{-2}, b = 0, 10, 30 MeV fm^{-3}. In these units, cħ = 197.3 MeV fm. The ground state energy I expected to lie between 90 and 110 MeV for all three cases.

4. Solve the s-wave radial Schrodinger equation for the vibrations of hydrogen molecule:

$$\frac{d^2y}{dr^2} = A(r).u(r), \quad A(r) = \frac{2m}{\hbar^2}[V(r) - E]$$

Where m is the reduced mass of the two-atom system for the Morse potential

$$V(r) = D(e^{-2\alpha r'} - e^{-\alpha r'}), \quad r' = \frac{r - r_o}{r}$$

Find the lowest vibrational energy (in MeV) of the molecule to an accuracy of three significant digits. Also plot the corresponding wave function.

Take: m = 940x10^6eV/C^2, D = 0.755501 eV, α = 1.44, r_o = 0.131349 Å

5. Solution of Ordinary Differential Equations (ODE)

First order Differential equation Euler, modified Euler and Runge-Kutta (RK) second and fourth order methods

(a) First order differential equation

- Radioactive decay
- Current in RC, LC circuits with DC source
- Newton's law of cooling
- Classical equations of motion

(b) Attempt following problems using RK 4 order method:

- Solve the coupled differential equations

$dx/dt = y + x - x^3/3$; $dy/dx = - x$

for four initial conditions x(0) = 0, y(0) = -1, -2, -3, -4.

Plot x vs y for each of the four initial conditions on the same screen for $0 \leq t \leq 15$.

Reference Books:

- Schaum's outline of Programming with C++.J.Hubbard, 20 00, McGraw-Hill Publication
- An introduction to computational Physics, T.Pang, 2nd Edn.,2006, Cambridge Univ. Press
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific & Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández.2014 Springer.
- Scilab (A Free Software to Matlab): H. Ramchandran, A.S. Nair. 2011 S. Chand & Co

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B.Sc.(H) Physics Sem-V
Paper: SOLID STATE PHYSICS
Paper Code: BPH-502

No. of Credits: 4	**Sessional: 25**
L: 4, T: 0	**Theory Exam: 75**
Theory: 60 Lectures	**Total: 100**

Course Objectives: This syllabus gives an introduction to the basic phenomena in Solid State Physics. This aims to provide a general introduction to theoretical and experimental topics in solid state physics. On successful completion of the module students should be able to elucidate the main features of crystal lattices and phonons, understand the elementary lattice dynamics and its influence on the properties of materials, describe the main features of the physics of electrons in solids; explain the dielectric ferroelectric and magnetic properties of solids and understand the basic concept in superconductivity.

Crystal Structure: Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors.Lattice with a Basis– Central and Non-Central Elements.Symmetry Elements Unit Cell. Miller Indices. Reciprocal Lattice. Bravais Lattices, SC, BCC, FCC, HCP Types of Lattices. Crystal structures of NaCl, ZnS, Diamond. Brillouin Zones. **(8 Lectures)**

Diffraction of X-rays by Crystals. Bragg‟s Law. Laue conditions. Atomic and Scattering Factor SC, BCC, FCC, NaCl, ZnS, Diamond. **(8 Lectures)**

Elementary Lattice Dynamics: Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains. Acoustical and Optical Phonons. Einstein and Debye theories of specific heat of solids. T^3 law. **(8 Lectures)**

Electrons in Solids: Density of states (1-D,2-D,3-D), Elementary band theory:Kronig Penny model (no derivation; Qualitative description only). Band Gap., Effective mass, Hall Effect (Metal and Semiconductor). **(8 Lectures)**

Magnetic Properties of Matter: Dia-, Para-, Ferri- and Ferromagnetic Materials. Classical Langevin Theory of dia– and Paramagnetic Domains. Curie‟s law, Weiss‟s Theory of Ferromagnetism and Ferromagnetic Domains, B-H Curve.Hysteresis, soft and hard material and Energy Loss. **(8 Lectures)**

Dielectric Properties of Materials: Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius Mosotti Equation. Normal and Anomalous Dispersion. Complex Dielectric Constant. **(10 Lectures)**

Ferroelectric Properties of Materials: Classification of crystals, Piezoelectric effect, Pyroelectric effect, Ferroelectric effect, Electrostrictive effect, Curie-Weiss Law, Ferroelectric domains, PE hysteresis loop. **(5 lectures)**

Superconductivity: Experimental Results. Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors, London‟s Equation and Penetration Depth. Isotope effect. Idea of BCS theory (No derivation) **(5 Lectures)**

COURSE OUTCOME

On successful completion of this course, students should be able to:

- Understand the crystal structure and lattice dynamics.
- Understand the band theory of solids.
- Learn the magnetic properties of solids.
- Understand the dielectric and ferroelectric properties of solids
- Understand the Superconductivity and its theories

Reference Books:

- Introduction to Solid State Physics, Charles Kittel, 8th Edn., 2004, Wiley India Pvt. Ltd.
- Elements of Solid State Physics, J.P. Srivastava, 2nd Edn., 2006, Prentice-Hall of India.
- Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill.
- Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning.
- Solid-state Physics, H.Ibach and H. Luth, 2009, Springer.
- Solid State Physics, Rita John, 2014, McGraw Hill
- Solid State Physics, M.A. Wahab, 2011, Narosa Publications.

B.Sc.(H) Physics Sem-V
Paper: Solid State Physics Lab
Paper Code: BPH-504

No. of Credits: 2 | **Sessional: 15**
L: 0, P: 4 | **External Exam: 35**
Lab: 60 Periods | **Total: 5**

At least 06 experiments from the following

1. Measurement of susceptibility of paramagnetic solution (Quinck`s Tube Method)
2. To measure the Magnetic susceptibility of Solids.
3. To determine the Coupling Coefficient of a Piezoelectric crystal.
4. To measure the Dielectric Constant of a dielectric Materials with frequency.
5. To determine the complex dielectric constant and plasma frequency of metal using Surface Plasmon resonance (SPR) technique.
6. To determine the refractive index of a dielectric using SPR technique.
7. To study the PE Hysteresis loop of a Ferroelectric Crystal.
8. To draw the BH curve of Fe using Solenoid & determine energy loss from Hysteresis.
9. To measure the resistivity of a semiconductor (Ge) with temperature (up to $150^{o}C$) by four-probe method and to determine its band gap.
10. To determine the Hall coefficient of a semiconductor sample.
11. To measure the resistivity of a semiconductor (Ge) with temperature by two-probe method and to determine its band gap.
12. Analysis of X-Ray diffraction data in terms of unit cell parameters and estimation of particle size.
13. Measurement of change in resistance of a semiconductor with magnetic field.

Reference Books:

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
- A Text Book of Practical Physics, I.Prakash& Ramakrishna, 11^{th} Ed., 2011, Kitab Mahal
- Elements of Solid State Physics, J.P. Srivastava, 2^{nd} Ed., 2006, Prentice-Hall of India.

Discipline Elective Course in Physics (DECP)
Semester-V

Select any two papers and corresponding lab (if any)

B.Sc.(H) Physics Sem-V
Paper: Atomic and Molecular Physics
Paper Code: DECP-501

No. of Credits: 6	**Sessional: 25**
L: 5, T: 1	**Theory Exam: 75**
Theory: 75 Lectures	**Total: 100**

COURSE OBJECTIVE: To understand the fundamentals of atomic and molecular physics. To provide a coherent and concise coverage of traditional atomic and molecular physics

General Atomic Theory: Determination of e/m of the Electron, Thompson, Helical Focussing method. Thermionic Emission, Dussmann's equation **(6 Lectures)**

X-rays :- Ionizing Power, Bohr Atomic Model, Critical Potentials, X-rays-Spectra: Continuous and Characteristic X-rays, Moseley Law. **(6 Lectures)**

Atoms in Electric and Magnetic Fields :- Electron Angular Momentum. Space Quantization. Electron Spin and Spin Angular Momentum. Larmor's Theorem. Spin Magnetic Moment. Stern-Gerlach Experiment. Zeeman Effect: Electron Magnetic Moment and Magnetic Energy, Gyromagnetic Ratio and Bohr Magneton. **(10 Lectures)**

Atoms in External Magnetic Fields :- Normal and Anomalous Zeeman Effect. Paschen Back and Stark Effect (Qualitative Discussion only). **(8 Lectures)**

Many electron atoms :- Pauli's Exclusion Principle. Symmetric and Antisymmetric Wave Functions. Periodic table. Fine structure. Spin orbit coupling. Spectral Notations for Atomic States. Total Angular Momentum. Vector Model. L-S and J-J couplings. Hund's Rule. Term symbols. Spectra of Hydrogen and Alkali Atoms (Na etc.). **(15 Lectures)**

Molecular Spectra :- Derivation of Rotational Energy levels, Selection Rules and Pure Rotational Spectra of a Molecule. Derivation of Vibrational Energy Levels, Selection Rules and Vibration Spectra. Rotation-Vibration Energy Levels, Selection Rules and Rotation-Vibration Spectra. Determination of Internuclear Distance. **(15 Lectures)**

Raman Effect :- Quantum Theory of Raman Effect. Characteristics of Raman Lines. Stoke's and Anti-Stoke's Lines. Complimentary Character of Raman and infrared Spectra. **(8 Lectures)**

Lasers :- Einstein's A and B coefficients. Metastable states. Spontaneous and Stimulated emissions. Optical Pumping and Population Inversion. Three-Level and Four-Level Lasers. Ruby Laser and He-Ne Laser. **(7 Lectures)**

COURSE OUTCOME

On successful completion of this course, students should be able to:

- Understand the fundamental aspects of atomic Physics.
- Understand the behavior of atoms in electric and magnetic fields
- Understand the rotational, vibrational molecular structure.
- Learn the Raman effect for structure determination of molecules
- Learn the fundamentals of Lasing action and some lasers.

Suggested Books:

1. Concepts of Modern Physics by Arthur Beiser (McGraw-Hill Book Company, 1987)
2. Atomic physics by J.B.Rajam & foreword by Louis De Broglie.(S.Chand & Co., 2007).
3. Atomic Physics by J.H.Fewkes & John Yarwood. Vol. II (Oxford Univ. Press, 1991).
4. Physics of Atoms and Molecules, Bransden and Joachein.
5. Molecular Spectroscopy, Banwell.
6. Optoelectronics by Ghatak and Thyagarajan
7. Principles of Lasers by Svelto

B.Sc.(H) Physics Sem-V

Paper: EXPERIMENTAL TECHNIQUES

Paper Code: DECP-502

No. of Credits: 4 **Sessional: 25**
L: 4T: 0 **Theory Exam: 75**
Theory: 60 Lectures **Total: 100**

Course Objectives: This paper aims to describe the errors in measurement and statistical analysis of data required while performing an experiment. Also, students will learn the working principle, efficiency and applications of transducers & industrial instruments like digital multimeter, RTD, Thermistor, Thermocouples and Semiconductor type temperature sensors.

Measurements: Accuracy and precision. Significant figures. Error and uncertainty analysis. Types of errors: Gross error, systematic error, random error. Statistical analysis of data (Arithmetic mean, deviation from mean, average deviation, standard deviation, chi-square) and curve fitting. Gaussian distribution. **(7 Lectures)**

Signals and Systems: Fluctuations and Noise in measurement system. S/N ratio and Noise figure. Noise in frequency domain. Sources of Noise: Inherent fluctuations, Thermal noise, Shot noise, 1/f noise **(3 Lectures)**

Shielding and Grounding: Methods of safety grounding. Energy coupling. Grounding. Shielding: Electrostatic shielding. Electromagnetic Interference. **(4 Lectures)**

Transducers & industrial instrumentation (working principle, efficiency, applications): Static and dynamic characteristics of measurement Systems. Generalized performance of systems, Zero order first order, second order and higher order systems. Electrical, Thermal and Mechanical systems. Calibration. Qualitative difference between Transducers and sensors.Types of sensors (Physical, Chemical and Biological), Characteristics of Transducers.Transducers as electrical element and their signal conditioning. Temperature transducers: RTD, Thermistor, Thermocouples, Semiconductor type temperature sensors (AD590, LM35, LM75) and signal conditioning. Linear Position transducer: Strain gauge, Piezoelectric. Inductance change transducer: Linear variable differential transformer (LVDT), Capacitance change transducers. Radiation Sensors: Principle of Gas filled detector, ionization chamber, scintillation detector. **(21 Lectures)**

Digital Multimeter: Comparison of analog and digital instruments. Block diagram of digital multimeter, principle of measurement of I, V, C. Accuracy and resolution of measurement.

(5 Lectures)

Impedance Bridges and Q-meter: Block diagram and working principles of RLC bridge. Q-meter and its working operation. Digital LCR bridge. **(4 Lectures)**

Vacuum Systems: Characteristics of vacuum: Gas law, Mean free path. Application of vacuum. Vacuum system- Chamber with roughing and backing, Mechanical pumps (Rotary and root pumps), Diffusion pump & Turbo Molecular pump, Ion pumps, Pumping speed, throughput, Pressure gauges (Pirani, Penning, ionization, cold cathode). **(16 Lectures)**

COURSE OUTCOME

On successful completion of this course, students should be able to:

- Understand the basics of measurements and error analysis.
- Understand the fundamentals of transducers and industrial instruments.
- Learn the working of digital multimeter and impedence bridges.
- Understand the theory and working of various vacuum systems.

Reference Books:

- Experimental Methods for Engineers, J.P. Holman, McGraw Hill
- Introduction to Measurements and Instrumentation, A.K. Ghosh, 3rd Edition, PHI Learning Pvt. Ltd.

- Transducers and Instrumentation, D.V.S. Murty, 2nd Edition, PHI Learning Pvt. Ltd.
- Instrumentation Devices and Systems, C.S.Rangan, G.R. Sarma, V.S.V. Mani, Tata McGraw Hill
- Electronic circuits: Handbook of design & applications, U.Tietze, Ch.Schenk, Springer

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B.Sc.(H) Physics Sem-V
Paper: Linear Algebra & Tensor Analysis
Paper Code: DECP-503

No. of Credits: 6	**Sessional: 25**
L: 5, T: 1	**Theory Exam: 75**
Theory: 75 Lectures	**Total: 100**

Course Objectives: The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.

Linear Vector Spaces Abstract Systems: Binary Operations and Relations. Introduction to Groups and Fields. Vector Spaces and Subspaces. Linear Independence and Dependence of Vectors. Basis and Dimensions of a Vector Space. Change of basis. Homomorphism and Isomorphism of Vector Spaces. Linear Transformations. Algebra of Linear Transformations. Non-singular Transformations. Representation of Linear Transformations by Matrices. **(12 Lectures)**

Matrices, Addition and Multiplication of Matrices: Null Matrices. Diagonal, Scalar and Unit Matrices. Upper-Triangular and Lower-Triangular Matrices. Transpose of a Matrix. Symmetric and Skew-Symmetric Matrices. Conjugate of a Matrix. Hermitian and Skew-Hermitian Matrices. Singular and Non-Singular matrices. Orthogonal and Unitary Matrices & their properties. Trace of a Matrix. Inner product of vectors. **(12 Lectures)**

Eigen-values and Eigenvectors: Finding Eigen – values and Eigen vectors of a Matrix. Diagonalization of Matrices. Properties of Eigen-values and Eigen Vectors of Orthogonal, Hermitian and Unitary Matrices. Cayley-Hamiliton Theorem(Statement only).Finding inverse of a matrix using Cayley-Hamiltion Theorem. Solutions of ordinary second order differential equations and Coupled Linear Ordinary Differential Equations of first order. Functions of a Matrix. **(12 Lectures)**

Transformation of Co-ordinates and fundamentals of Tensors. Einstein's Summation Convention. Relation between Direction Cosines. Tensors. Algebra of Tensors. Sum, Difference and Product of Two Tensors. Contraction. Quotient Law of Tensors. Symmetric and Anti-symmetric Tensors. Invariant Tensors : Kronecker and Alternating Tensors. Association of Antisymmetric Tensor of Order Two and Vectors. **(12 lectures)**

Cartesian Tensors: Vector Algebra and Calculus using Cartesian Tensors : Scalar and Vector Products, Scalar and Vector Triple Products. Differentiation. Gradient, Divergence and Curl of Tensor Fields. Tensor notation of Laplacian operator. Proof of Vector Identities involving scalar and vector products and vector identities involving Del operator under Tensor notation. Isotropic Tensors (Definition only). Tensorial Character of Physical Quantities. Moment of Inertia Tensor. Stress and Strain Tensors : Symmetric Nature. Elasticity Tensor. Generalized Hooke‟s Law. **(15 lectures)**

General Tensors Transformation of Co-ordinates. Minkowski Space. Contravariant & Covariant Vectors. Contravariant, Covariant and Mixed Tensors. Kronecker Delta and Permutation Tensors. Algebra of Tensors. Sum, Difference & Product of Two Tensors. Contraction. Quotient Law of Tensors. Symmetric and Anti-symmetric Tensors. Metric Tensor. **(12 Lectures)**

COURSE OUTCOME

On successful completion of this course, students should be able to:

- Understand the linear algebra and fundamentals of matrices.
- Determine the eigen values and eigen vectors of matrices and their properties.
- Understand the transformation of coordinates and fundamentals of Tensors.
- Learn the Cartesion Tensors and the general algebra of tensors.

Reference Books:

- Mathematical Tools for Physics, James Nearing, 2010, Dover Publications
- Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber and F.E.Harris,1970, Elsevier.
- Modern Mathematical Methods for Physicists and Engineers, C.D. Cantrell, 2011, Cambridge University Press
- Introduction to Matrices & Linear Transformations, D.T.Finkbeiner,1978, Dover Pub.
- Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole

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BSc (H) Physics Sem-V
Paper: EXPERIMENTAL TECHNIQUES Lab
Paper Code: DECP-504

No. of Credits: 2	**Internal: 15**
L: 0, T: 0, P: 4	**External Exam: 35**
60 Periods	**Total: 50**

At least 06 experiments each from the following:

1. Determine output characteristics of a LVDT & measure displacement using LVDT
2. Measurement of
   (a) Strain using Strain Gauge,
   (b) level using capacitive transducer.
   (c) distance using ultrasonic transducer
3. To study the characteristics of a Thermostat and determine its parameters.
4. Calibrate Semiconductor type temperature sensor (AD590, LM35, LM75) and Resistance Temperature Device (RTD).
5. Create vacuum in a small chamber using a mechanical (rotary) pump and measure the chamber pressure using a pressure gauge.
6. Comparison of pickup of noise in cables of different types (co-axial, single shielded, double shielded, without shielding) of 2mlength, understanding of importance of grounding using function generator of mV level & an oscilloscope.
7. To design and study the Sample and Hold Circuit.
8. Design and analyze the Clippers and Clampers circuits using junction diode
9. To plot the frequency response of a microphone.
10. To measure Q of a coil and influence of frequency, using a Q-meter.

Reference Books:

- Electronic circuits: Handbook of design and applications, U.Tietze and C.Schenk, 2008, Springer
- Basic Electronics:A text lab manual, P.B.Zbar, A.P.Malvino, M.A.Miller, 1990, Mc-Graw Hill
- Measurement, Instrumentation and Experiment Design in Physics & Engineering, M.Sayer and A. Mansingh, 2005, PHI Learning.

B.Sc.(H) Physics Sem-V
Paper: Biological & Medical Physics
Paper Code: DECP-505

No. of Credits: 6 — **Sessional: 25**
L: 5, T: 1 — **Theory Exam: 75**

Theory: 75 Lectures — Total: 100

Course Objectives: The Biological Physics course introduces the emerging inter-disciplinary field on the interface of Physics and Biology. It makes use of concepts from Physics and discusses their application in Biology. This course helps the students to develop a system level perspective of Biology and equips them with the required mathematical and computational skills.

Overview: The boundary, interior and exterior environment of living cells. Processes: exchange of matter and energy with environment, metabolism, maintenance, reproduction, evolution. Self-replication as a distinct property of biological systems. Time scales and spatial scales. Allometric scaling laws. (6 Lectures)

Molecules of life: Metabolites, proteins and nucleic acids. Their sizes, types and roles in structures and processes. Transport, energy storage, membrane formation, catalysis, replication, transcription, translation, signaling. Typical populations of molecules of various types present in cells, their rates of production and turnover. Energy required to make a bacterial cell. small genetic circuits and signaling pathways (overview only). (12 Lecture)

Molecular motion in cells: Random walks and applications to biology: Diffusion; models of macromolecules. Entropic forces: Osmotic pressure; polymer elasticity. Chemical forces: Self assembly of amphiphiles. Molecular motors: Transport along microtubules. (17 Lectures)

Brain structure: neurons and neural networks. Brain as an information processing system. At the level of an ecosystem and the biosphere: Foodwebs. Feedback cycles and self sustaining ecosystems. (8 Lectures)

Evolution: The mechanism of evolution: variation at the molecular level, selection at the level of the organism. Models of evolution. The concept of genotype-phenotype map. Examples. (9 Lectures)

Physics of The Body: Acoustics of the body: Nature and characteristics of sound, Production of speech, Physics of the ear, Diagnostics with sound and ultrasound. Optical system of the body: Physics of the eye. Electrical system of the body: Physics of the nervous system, Electrical signals and information transfer. Physics of cardiovascular system. Basics of CPR (15 Lectures)

Physics of Diagnostic And Therapeutic Systems: Diagnostic nuclear medicine: Radiopharmaceuticals for radioisotope imaging, Radioisotope imaging equipment, Single photon and positron emission tomography. Therapeutic nuclear medicine: Interaction between radiation and matter Dose and isodose in radiation treatment. Medical Instrumentation: Basic Ideas of

Endoscope and Cautery, Sleep Apnea and Cpap Machines, Ventilator and its modes. (8 Lectures)

Reference Books:

- Biological Physics: Energy, Information, Life; Philip Nelson (W H Freeman• &Co, NY, 2004)
- Physical Biology of the Cell (2nd Edition); Rob Phillips et al (Garland Science,• Taylor & Francis Group, London & NY, 2013)
- An Introduction to Systems Biology; Uri Alon (Chapman and Hall/CRC, Special• Indian Edition, 2013) Evolution; M. Ridley (Blackwell Publishers, 2009, 3rd edition)
- Medical Physics, J.R. Cameron and J.G.Skofronick, Wiley (1978)
- Basic Radiological Physics Dr. K.Thayalan- Jayapee Brothers Medical Publishing Pvt.• Ltd. New Delhi (2003)
- Christensen‟s Physics of Diagnostic Radiology: Curry, Dowdey and Murry - Lippincot• Williams and Wilkins (1990)
- Physics of the human body, Irving P. Herman, Springer (2007).
- Physics of Radiation Therapy: F M Khan - Williams and Wilkins, 3rdedition (2003)
- The essential physics of Medical Imaging: Bushberg, Seibert, Leidholdt and Boone• Lippincot Williams and Wilkins, Second Edition (2002)
- Handbook of Physics in Diagnostic Imaging: R.S.Livingstone: B.I. Publication Pvt Ltd.
- The Physics of Radiology-H E Johns and Cunningham.

Syllabus of B.Sc. (H) Physics

Semester VI

Discipline Core Course (DCC)

B.Sc.(H) Physics Sem-VI
Paper: ELECTROMAGNETIC THEORY
Paper Code: BPH-601

No. of Credits: 4	**Sessional: 25**
L: 4, T: 0	**Theory Exam: 75**
Theory: 60 Lectures	**Total: 100**

Electromagnetic theory is a core course in B. Sc. (Honours) Physics curriculum. The course covers Maxwell's equations, propagation of electromagnetic (em) waves in different homogeneous-isotropic as well as anisotropic unbounded and bounded media, production and detection of different types of polarized em waves, general information as waveguides and fibre optics.

Maxwell Equations: Review of Maxwell's equations. Displacement Current. Vector and Scalar Potentials. Gauge Transformations: Lorentz and Coulomb Gauge. Poynting Theorem and Poynting Vector. Electromagnetic (EM) Energy Density. Physical Concept of Electromagnetic Field Energy Density. Momentum Density and Angular Momentum Density. **(12 Lectures)**

EM Wave Propagation in Unbounded Media: Plane EM waves through vacuum and isotropic dielectric medium, transverse nature of plane EM waves, refractive index and dielectric constant, wave impedance. Propagation through conducting media, relaxation time, skin depth. Wave propagation through dilute plasma, electrical conductivity of ionized gases, plasma frequency, refractive index, skin depth, application to propagation through ionosphere. **(12 Lectures)**

EM Wave in Bounded Media: Boundary conditions at a plane interface between two media. Reflection & Refraction of plane waves at plane interface between two dielectric media-Laws of Reflection & Refraction. Fresnel's Formulae for perpendicular & parallel polarization cases, Brewster's law. Reflection & Transmission coefficients. Total internal reflection, evanescent waves. Metallic reflection (normal Incidence) **(12 Lectures)**

Polarization of Electromagnetic Waves: Description of Linear, Circular and Elliptical Polarization. Propagation of E.M. Waves in Anisotropic Media. Uniaxial and Biaxial Crystals.

Light Propagation in Uniaxial Crystal. Double Refraction. Polarization by Double Refraction. Nicol Prism. Ordinary & extraordinary refractive indices. Production & detection of Plane, Circularly and Elliptically Polarized Light. **(12 Lectures)**

Wave Guides: Planar optical wave guides. Wave equations for circular and rectangular hollow waveguides. TE, TM and TEM modes in rectangular wave guides. Condition of continuity at interface. Concept of cutoff frequency. Phase and group velocity of guided waves. **(9 Lectures)**

Optical Fibres: Numerical Aperture. Step and Graded Indices (Definitions Only). Single and Multiple Mode Fibres. **(3 Lectures)**

COURSE OUTCOMES

Students who have completed this course should

- Have a deep understanding of Maxwell's electromagnetic theory and propagation of EM waves though various media.
- Be able to understand the phenomena of reflection, refraction, polarization and dispersion of EM waves in bound media.
- Understand the polarization of electromagnetic waves.
- Be able to understand the concepts of waveguides and optical fibres.

Reference Books:

- Introduction to Electrodynamics, D.J. Griffiths, 3rd Ed., 1998, Benjamin Cummings.
- Electromagnetic Field and Waves, P. Lorrain and D. Corson, 2nd Ed., 2003, CBS Publisher.
- Elements of Electromagnetics, M.N.O. Sadiku, 2001, Oxford University Press.
- Fundamentals of Electromagnetics, M.A.W. Miah, 1982, Tata McGraw Hill
- Electromagnetic field Theory, R.S. Kshetrimayun, 2012, Cengage Learning
- Engineering Electromagnetic, Willian H. Hayt, 8th Edition, 2012, McGraw Hill.
- Electromagnetics, J.A. Edminster, Schaum Series, 2006, Tata McGraw Hill.
- Electromagnetic field theory fundamentals, B.Guru and H.Hiziroglu, 2015, Cambridge University Press
- Classical Electrodynamics, J.D. Jackson, 3rd Edn., 2010, Wiley
- Principle of Optics, M. Born and E. Wolf, 6th Edn., 1980, Pergamon Press
- Optics, A. Ghatak, 5th Edn., 2012, Tata McGraw Hill Education.

B.Sc.(H) Physics Sem-VI
Paper: Electromagnetic theory Lab
Paper Code: BPH-603

No. of Credits: 2	**Sessional: 15**
L: 0, P: 4	**External Exam: 35**
Lab: 60 Periods	**Total: 50**

The laboratory content compliments the theoretical knowledge of Electromagnetic Theory and gives hands-on experience. Also, it provides the observational understanding of the subject. It enhances the qualitative and quantitative skills of the students.

At least 06 experiments from the following

1. To verify the law of Malus for plane polarized light.
2. To determine the specific rotation of sugar solution using Polarimeter.
3. To analyze elliptically polarized Light by using a Babinet"s compensator.
4. To study dependence of radiation on angle for a simple Dipole antenna.
5. To determine the wavelength and velocity of ultrasonic waves in a liquid (Kerosene Oil, Xylene, etc.) by studying the diffraction through ultrasonic grating.
6. To study the reflection, refraction of microwaves
7. To study Polarization and double slit interference in microwaves.
8. To determine the refractive index of liquid by total internal reflection using Wollaston"s air-film.
9. To determine the refractive Index of (1) glass and (2) a liquid by total internal reflection using a Gaussian eyepiece.
10. To study the polarization of light by reflection and determine the polarizing angle for air-glass interface.
11. To verify the Stefan`s law of radiation and to determine Stefan"s constant.
12. To determine Boltzmann constant using V-I characteristics of PN junction diode.
13. To find Numerical Aperture of an Optical Fibre.
14. To verify Brewster"s Law and to find the Brewster"s angle.

Reference Books:

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer

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B.Sc.(H) Physics Sem-VI
Paper: STATISTICAL MECHANICS
Paper Code: BPH-602

No. of Credits: 4	**Sessional: 25**
L: 4, T: 0	**Theory Exam: 75**
Theory: 60 Lectures	**Total: 100**

Course Objectives: The Statistical Mechanics deals with the derivation of the macroscopic parameters (internal energy, pressure, specific heat etc.) of a physical system consisting of large number of particles (solid, liquid or gas) from knowledge of the underlying microscopic behavior of atoms and molecues that comprises it. The main objective of this course work is to introduce the techniques of Statistical Mechanics which has applications in various fields including Astrophysics, Semiconductors, Plasma Physics, Bio-Physics, Chemistry and in many other directions.

Unit I : Classical Statistics

Macrostate and Microstate, Phase Space, Elementary Concept of Ensemble, Entropy and Thermodynamic Probability, Maxwell-Boltzmann Distribution Law, Partition Function, Thermodynamic Functions of an Ideal Gas, Classical Entropy Expression, Gibbs Paradox, Sackur-Tetrode equation, Law of Equipartition of Energy (with proof)– Applications to Specific Heat and its Limitations, Thermodynamic Functions of a Two-Energy Levels System, Negative Temperature. **(18 Lectures)**

Unit II:Bose-Einstein Statistics:

B-E distribution law, Thermodynamic functions of a strongly Degenerate Bose Gas, Bose Einstein condensation, properties of liquid He (qualitative description), Radiation as a photon gas and Thermodynamic functions of photon gas. Bose derivation of Planck"s law. **(13 Lectures)**

Unit III:Fermi-Dirac Statistics:

Fermi-Dirac Distribution Law, Thermodynamic functions of a Completely and strongly Degenerate Fermi Gas, Fermi Energy, Electron gas in a Metal, Specific Heat of Metals, Relativistic Fermi gas, White Dwarf Stars, Chandrasekhar Mass Limit. **(15 Lectures)**

Unit IV : Theory of Radiation

Properties of Thermal Radiation. Blackbody Radiation. Pure temperature dependence. Radiation Pressure. Kirchhoff"s law. Stefan-Boltzmann law: Thermodynamic proof. Wien"s Displacement law. Wien"s Distribution Law. Saha"s Ionization Formula. Rayleigh-Jean"s Law. Ultraviolet

Catastrophe. Spectral Distribution of Black Body Radiation. Planck‟s Quantum Postulates. Planck‟s Law of Blackbody Radiation: Experimental Verification. Deduction of (1) Wien‟s Distribution Law, (2) Rayleigh-Jeans Law, (3) Stefan-Boltzmann Law, (4) Wien‟s Displacement law from Planck‟s law. **(14 Lectures)**

COURSE OUTCOME

On successful completion of this course, students should be able to:

- Have a understanding of classical statistics of Maxwell-Boltzmann and its applications.
- Understand the quantum statistics of Bose-Einstein and its applications.
- Understand the Fermi-Dirac statistics and its applications.
- Have a basic understanding theory of radiations.

Reference Books:

- Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.
- Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill
- Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.
- An Introduction to Statistical Mechanics & Thermodynamics, R.H.Swendsen, 2012, Oxford Univ. Press
- Statistical Physics , F. Mandl, 2nd Edn., 2003, Wiley
- Introductory Statistical Mechanics, R. Bowley and M. Sanchez, 2nd Edn., 2007, Oxford Univ. Press
- A treatise on Heat, M. N. Saha and B.N. Srivastava

B.Sc.(H) Physics Sem-VI
Paper: STATISTICAL MECHANICS Lab
Paper Code: BPH-604

No. of Credits: 2 **Sessional: 15**
L: 0, P: 4 **External Exam: 35**
Lab: 60 Periods **Total: 50**

Use C/C++/Scilab/other numerical simulations for solving the problems based on Statistical Mechanics like

1. Computational analysis of the behavior of a collection of particles in a box that satisfy Newtonian mechanics and interact via the Lennard-Jones potential, varying the total number of particles N and the initial conditions:

a. Study of local number density in the equilibrium state (i) average; (ii) fluctuations.
b. Study of transient behavior of the system (approach to equilibrium)
c. Relationship of large N and the arrow of time.
d. Computation of the velocity distribution of particles for the system and comparison with the Maxwell velocity distribution.
e. Computation and study of mean molecular speed and its dependence on particle mass.
f. Computation of fraction of molecules in an ideal gas having speed near the most probable speed

2. Computation of the partition function Z(□) for examples of systems with a finite number of single particle levels (e.g., 2 level, 3 level, etc.) and a finite number of non-interacting particles N under Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein statistics:

a. Study of how $Z(\beta)$, average energy $\langle E \rangle$, energy fluctuation ΔE, C_v, depend upon the temperature, total number of particles N and the spectrum of single particle states.
b. Ratios of occupation numbers of various states for the systems considered above.
c. Computation of physical quantities at large and small temperature T and comparison of various statistics at large and small temperature T.

3. Plot Planck"s law for Black Body radiation and compare it with Raleigh-Jeans Law at large and small wavelength for a given temperature.

4. Plot Specific Heat of Solids (a) Dulong-Petit law, (b) Einstein distribution function, (c) Debye distribution function for high temperature and low temperature and compare them for these two cases.

5. Plot the following functions with energy at different temperatures

a) Maxwell-Boltzmann distribution
b) Fermi-Dirac distribution
c) Bose-Einstein distribution

6. Plot the distribution of particles w.r.t. energy (dN/dε versus ε) for

a) Relativistic and non-relativistic bosons both at high and low temperature.
b) Relativistic and non-relativistic fermions both at high and low temperature.

Laboratory based Experiments

7. To determine the Planck's constant using LEDs of at least 4 different colours.
8. To verify the Stefan`s law of radiation and to determine Stefan's constant.
9. To determine Boltzmann constant using I-V characteristics of PN junction diode.

Reference Books:

- ElementaryNumericalAnalysis, K.E.Atkinson, 3rd Edn. 2007, WileyIndiaEdition
- Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.
- Introduction to Modern Statistical Mechanics, D.Chandler, Oxford University Press, 1987
- Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.
- Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer
- Statistical and Thermal Physics with computer applications, Harvey Gould and Jan Tobochnik, Princeton University Press, 2010.

Discipline Elective Course in Physics (DECP)
Semester-VI

Select any two papers and corresponding lab (if any)

B.Sc.(H) Physics Sem-VI
Paper: Nuclear and Particle Physics
Paper Code: DECP-601

No. of Credits: 6 | **Sessional: 25**
L: 5, T: 1 | **Theory Exam: 75**
Theory: 75 Lectures | **Total: 100**

Course Objectives: The objective of the course is to impart the understanding of the sub atomic particles and their properties. It will emphasize to gain knowledge about the different nuclear techniques and their applications in different branches of Physics and societal application. The course will focus on the developments of problem based skills.The acquire knowledge can be applied in the areas of nuclear, medical, archeology, geology and other interdisciplinary fields of Physics and Chemistry. It will enhance the special skills required for these fields.

General Properties of Nuclei: Constituents of nucleus and their Intrinsic properties, quantitative facts about mass, radii, charge density, nuclear matter density, binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve, N/Z plot, angular momentum, parity, magnetic moment, electric moments **(10 Lectures)**

Nuclear Models: Liquid drop model approach, semi empirical mass formula and significance of its various terms, condition of nuclear stability, Fermi gas model (degenerate fermion gas, nuclear symmetry potential in Fermi gas), evidence for nuclear shell structure and the basic assumption of shell model **(11 Lectures)**

Radioactivity decay: (a) Alpha decay: basics of α-decay processes, theory of α-emission, Gamow factor, Geiger Nutt all law, α-decay spectroscopy, decay Chains. (b) β -decay: energy kinematics for β -decay, β-spectrum, positron emission, electron capture, neutrino hypothesis. (c) Gamma decay: Gamma rays emission from the excited state of the nucleus & kinematics **(10 Lectures)**

Nuclear Reactions: Types of Reactions, units of related physical quantities, Conservation Laws, kinematics of reactions, Q-value, reaction rate, reaction cross section, Concept of compound and direct Reaction, resonance reaction, Coulomb scattering (Rutherford scattering). **(8 Lectures)**

Interaction of Nuclear Radiation with matter: Energy loss due to ionization (Bethe-Block formula), energy loss of electrons, Cerenkov radiation. Gamma ray interaction through matter(photoelectric effect, Compton scattering, pair production), neutron interaction with matter. **(9 Lectures)**

Detector for Nuclear Radiations: Gas detectors: estimation of electric field, mobility of particle for ionization chamber and GM Counter. Basic principle of Scintillation Detectors and construction of photo-multiplier tube (PMT).Semiconductor Detectors (Si and Ge) for charge particle and photon detection (concept of charge carrier and mobility), neutron detector. **(9 Lectures)**

Particle Accelerators: Accelerator facility available in India: Van-de Graaff generator (Tandem accelerator), Linear accelerator, Cyclotron, Synchrotrons (Principle, construction, working, advantages and disadvantages). . **(7 Lectures)**

Particle physics: Particle interactions (concept of different types of forces); basic features, types of particles and its families. Conservation Laws(energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin, Strangeness), concept of quark model, color quantum number and gluons. **(11 Lectures)**

COURSE OUTCOME

After the successful completion of the course, students would be able to:

- Describe the basic interaction mechanisms for charged particles and electromagnetic radiation and explain the working principles behind detectors and their characteristic properties with respect to energy resolution, efficiency etc.
- Understand the mechanism and kinematics of nuclear reactions.
- Describe the basic features involved in alpha and beta decays and nuclear forces
- Comprehend the fundamentals of elementary particle physics.

Reference Books:

- Nuclear Physics by I. Kapelon.
- Nuclear Physics by W.E. Burcham.
- Nuclear Physics by Enge.
- Atomic Nucleus by Evans.
- Nuclear Physics by S. N. Ghoshal, First edition, S. Chand Publication, 2010.
- Concepts of Nuclear Physics by Bernard L Cohen, Tata McGraw Hill Publication, 1974.
- Introductory Nuclear Physics by Kenneth S, Krane, Wiley-India Publication, 2008
- Radiation detection and measurement, G.F. Knoll, John Wiley & Sons, 2010.
- Introduction to elementary particles by David J Griffiths, Wiley, 2008.

B.Sc.(H) Physics Sem-VI
Paper: Nano Materials and Applications
Paper Code: DECP-602

No. of Credits: 4 | **Sessional: 25**
L: 4, T: 0 | **Theory Exam: 75**
Theory: 60 Lectures | **Total: 100**

Course Objectives: This course introduces the essence of nano materials, their synthesis, and characterization. On successful completion of the module students should also be able to understand the optical properties and electron transport phenomenon in nanostructures. It also covers few important applications of nano materials used in this technological era.

NANOSCALE SYSTEMS: Density of states (1-D,2-D,3-D). Length scales in physics, Nanostructures: 1D, 2D and 3D nanostructures (nanodots, thin films, nanowires, nanorods)**,** Band structure and density of states of materials at nanoscale, Size Effects in nano systems, Applications of Schrodinger equation- Infinite potential well, potential step, potential box, quantum confinement of carriers in 3D, 2D, 1D nanostructures and its consequences. **(10 Lectures)**

SYNTHESIS OF NANOSTRUCTURE MATERIALS: Top down and Bottom up approach, Ball milling. Gas phase condensation. Vacuum deposition. Physical vapor deposition (PVD): Thermal evaporation, Chemical vapor deposition (CVD).Sol-Gel. Spray pyrolysis. Hydrothermal synthesis. Preparation through colloidal methods. **(8 Lectures)**

CHARACTERIZATION: X-Ray Diffraction. Optical Microscopy. Scanning Electron Microscopy. Transmission Electron Microscopy. Atomic Force Microscopy. Scanning Tunneling Microscopy. **(8 Lectures)**

OPTICAL PROPERTIES: Concept of dielectric constant for nanostructures and charging of nanostructure. Quasi-particles and excitons. Excitons in direct and indirect band gap semiconductor nanocrystals. Quantitative treatment of quasi-particles and excitons, charging effects. Radiative processes: General formalization-absorption, emission and luminescence. Optical properties of heterostrctures and nanostructures. **(14 Lectures)**

ELECTRON TRANSPORT: Carrier transport in nanostrcutures. Coulomb blockade effect, thermionic emission, tunneling and hopping conductivity. Defects and impurities: Deep level and surface defects. **(6 Lectures)**

APPLICATIONS: Applications of nanoparticles, quantum dots, nanowires and thin films for photonic devices (LED, solar cells). CNT based transistors. Nanomaterial Devices: Quantum dots heterostructure lasers, optical switching and optical data storage. Magnetic quantum well; Micro Electromechanical Systems (MEMS), Nano Electromechanical Systems (NEMS). **(14 Lectures)**

COURSE OUTCOME

After the successful completion of the course, students would be able:

- To understand the basics of Nano Science and Nano Technology.
- To apply the Quantum Mechanics for Nanomaterials.
- To learn the various Growth Techniques of Nanomaterials.
- To use the Characterization Tools of Nanomaterials for research applications.

Reference books:

C.P.Poole, Jr. Frank J.Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.)

- S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publishing Company)
- K.K. Chattopadhyay and A. N. Banerjee, Introduction to Nanoscience and Technology (PHI Learning Private Limited).
- Introduction to Nanoelectronics, V.V. Mitin, V.A. Kochelap and M.A. Stroscio, 2011, Cambridge University Press.
- Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).

B.Sc.(H) Physics Sem-IV
Paper: Nano Materials and Applications Lab
Paper Code: DECP-604

No. of Credits: 2	**Sessional: 15**
L: 0, P: 4	**External Exam: 35**
Lab: 60 Periods	**Total: 50**

At least 04 experiments from the following:

1. Synthesis of metal nanoparticles by chemical route.
2. Synthesis of semiconductor nanoparticles.
3. Surface Plasmon study of metal nanoparticles by UV-Visible spectrophotometer.
4. Analysis of XRD pattern of nanomaterials and estimation of particle size.
5. To study the effect of size on color of nanomaterials.
6. To prepare composite of CNTs with other materials.
7. Growth of quantum dots by thermal evaporation.
8. Prepare a disc of ceramic of a compound using ball milling, pressing and sintering, and study its XRD.
9. Fabricate a thin film of nanoparticles by spin coating (or chemical route) and study transmittance spectra in UV-Visible region.

10. Prepare a thin film capacitor and measure capacitance as a function of temperature or frequency.
11. Fabricate a PN diode by diffusing Al over the surface of N-type Si and study its V-I characteristic.

Reference Books:

- C.P.Poole, Jr. Frank J.Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.).
- S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publishing Company).
- K.K. Chattopadhyay and A.N. Banerjee, Introduction to Nanoscience & Technology (PHI Learning Private Limited).
- Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).

B.Sc.(H) Physics Sem-VI
Paper: PHYSICS OF DEVICES AND COMMUNICATION
Paper Code: DECP-603

No. of Credits: 4	**Sessional: 25**
L: 4, T: 0	**Theory Exam: 75**
Theory: 60 Lectures	**Total: 100**

Course Objectives: This paper is based on advanced electronics which covers the devices such as UJT, JFET, MOSFET, CMOS etc. Process of IC fabrication is discussed in detail. Digital Data serial and parallel Communication Standards are described along with the understanding of communication systems.

Devices: Characteristic and small signal equivalent circuits of UJT and JFET. Metal-semiconductor Junction. Schottky diode, Metal oxide semiconductor (MOS) device. Ideal MOS and Flat Band voltage. SiO_2-Si based MOS, C-V characteristics of MOS, MOSFET– their frequency limits. Enhancement and Depletion Mode MOSFETS, basic idea of CMOS. ***(15 Lectures)***

Processing of Devices: Basic process flow for IC fabrication. Crystal plane and orientation. Diffusion and implantation of dopants. Passivation. Oxidation Technique for Si. Contacts and metallization technique. Wet etching. Dry etching (RIE). Photolithography. Electron-lithography, Basic idea of SSI, MSI, LSI, VLSI and USI. **(15 Lectures)**

RC Filters: Passive-Low pass and High pass filters, Active (1^{st} order butterworth) –Low Pass, High Pass, Band Pass and band Reject Filters. **(3 Lectures)**

Phase Locked Loop (PLL): Basic Principles, Phase detector (XOR and edge triggered), Voltage Controlled Oscillator (Basics, varactor). Lock and capture. Basic idea of PLL IC (565 or 4046). **(6 Lectures)**

Digital Data Communication Standards:

Serial Communications*: RS232, Handshaking, Implementation of RS232 on PC, Universal Serial Bus (USB), USB standards, Types and elements of USB transfers.* ***(5 Lectures)***

Introduction to communication systems: Block diagram of electronic communication system, Need for modulation. Amplitude modulation. Modulation Index. Analysis of Amplitude Modulated wave. Sideband frequencies in AM wave. CE Amplitude Modulator. Demodulation of AM wave using Diode Detector. Frequency modulation and demodulation, basic idea of Frequency, Phase, Pulse and Digital Modulation including ASK, PSK, FSK. **(15 lectures)**

COURSE OUTCOME

On successful completion of this course, students should be able to:

- *Understand the fabrication and study of advanced electronic device.*
- *Learn the basics of IC fabrication process and various scales of IC fabrication.*
- *Learn various electronic filters and Phase Locked Loop circuits*
- *Understand standards of communication the various communication systems*

Reference Books:

- *Physics of Semiconductor Devices, S.M.Sze and K.K.Ng, 3rd Edition 2008, John Wiley & Sons*
- *Op-Amps & Linear Integrated Circuits, R.A.Gayakwad,4 Ed. 2000, PHI Learning Pvt. Ltd*
- *Electronic Devices and Circuits, A. Mottershead, 1998, PHI Learning Pvt. Ltd*
- Electronic Communication systems, G. Kennedy, 1999, Tata McGraw Hill.
- Introduction to Measurements & Instrumentation, A.K.Ghosh, 3rd Edition, 2009, PHI Learning
- Semiconductor Physics and Devices, D.A. Neamen, 2011, 4th Edition, McGraw Hill
- PC based instrumentation; Concepts and Practice, N. Mathivanan, 2007, Prentice-Hall of India

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B.Sc.(H) Physics Sem-VI

Paper: PHYSICS OF DEVICES AND COMMUNICATION Lab

Paper Code: DECP-605

No. of Credits: 2	**Sessional: 15**
L: 0, P: 4	**External Exam: 35**
Lab: 60 Periods	**Total: 50**

At least 06 experiments each from section-A and section-B:

Section-A:

1. Design and analyze the Clippers and Clampers circuits using junction diode
2. To design a power supply using bridge rectifier and study effect of C-filter.

3. To design the active Low pass and High pass filters of given specification.
4. To design the active filter (wide band pass and band reject) of given specification.
5. To study the output and transfer characteristics of a JFET.
6. To design a common source JFET Amplifier and study its frequency response.
7. To study the output characteristics of a MOSFET.
8. To study the characteristics of a UJT and design a simple Relaxation Oscillator.
9. To design and study an Amplitude Modulator using Transistor.
10. To design PWM, PPM, PAM and Pulse code modulation using ICs.
11. To design an Astable multivibrator of given specifications using transistor.
12. To study a PLL IC (Lock and capture range).
13. To study envelope detector for demodulation of AM signal.
14. Study of ASK and FSK modulator.
15. Glow an LED via USB port of PC.
16. Sense the input voltage at a pin of USB port and subsequently glow the LED connected with another pin of USB port.

Section-B: ***SPICE/MULTISIM simulations for electronic circuits and devices***

1. To verify the Thevenin and Norton Theorems.
2. Design and analyze the series and parallel LCR circuits
3. Design the inverting and non-inverting amplifier using an Op-Amp of given gain
4. Design and Verification of op-amp as integrator and differentiator
5. Design the 1^{st}order active low pass and high pass filters of given cutoff frequency
6. Design a Wein`s Bridge oscillator of given frequency.
7. Design clocked SR and JK Flip-Flop`s using NAND Gates
8. Design 4-bit asynchronous counter using Flip-Flop ICs
9. Design the CE amplifier of a given gain and its frequency response.
10. Design an Astable multivibrator using IC555 of given duty cycle.
11. To study the characteristics of a Thermostat and determine its parameters.
12. Calibrate Semiconductor type temperature sensor (AD590, LM35, LM75) and Resistance Temperature Device (RTD).

Reference Books:

- Basic Electronics: A text lab manual, P.B.Zbar, A.P.Malvino, M.A.Miller,1994, Mc-Graw Hill
- Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
- Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
- OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4^{th} edn., 2000, Prentice Hall.
- Introduction to PSPICE using ORCAD for circuits& Electronics, M.H.Rashid,2003, PHI Learning.
- PC based instrumentation; Concepts & Practice, N.Mathivanan, 2007, Prentice-Hall of India

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B.Sc.(H) Physics Sem-VI
Paper: CLASSICAL DYNAMICS
Paper Code: DECP-606

No. of Credits: 6 | **Sessional: 25**
L: 5, T: 1 | **Theory Exam: 75**

Theory: 75 Lectures | Total: 100

COURSE OBJECTIVE

The course aims to develop an understanding of Lagrangian and Hamiltonian which allow simplified treatments of many problems in classical mechanics. The course aims to provide the foundation for the modern understating of dynamics.

Lagrangian and Hamiltonian formulations
Review of Newtonian Mechanics and its Application to the motion of a charge particle in uniform external electric and magnetic fields- gyroradius and gyrofrequency. Degrees of freedom of a system, Generalized coordinates and velocities. Hamilton's principle, Lagrangian and Lagrange's equations of motion of one-dimensional simple harmonic oscillators, falling body in uniform gravity. Cyclic coordinates. Derivation of Lagrange's equations from Hamilton's principle, Principle of Least Action and its applications, Canonical Transformation; Canonical momenta & Hamiltonian. The physical significance of the Hamiltonian, Hamilton's equations of motion. Comparison of Newtonian, Lagrangian and Hamiltonian mechanics. Applications of Hamiltonian mechanics: Hamiltonian for a simple harmonic oscillator, solution of Hamilton's equations for simple harmonic oscillations (1-D), particle in a central force field – conservation of angular momentum and energy. (25 lecture)

Poisson bracket and theory of small oscillations
Poisson bracket, Poisson theorem, Poisson bracket and canonical transformation, Jacobi identity and its derivation, Lagrange bracket and its properties, the relationship between Poisson and Lagrange brackets and its derivation, the angular momenta and Poisson bracket, Liouville's theorem and its applications. (10 Lectures)
Small Amplitude Oscillations: Minima of potential energy and points of stable equilibrium, Theory of small oscillations: small amplitude oscillations about the minimum, normal modes of longitudinal simple harmonic oscillations (maximum 2 masses connected by 3 springs). Kinetic energy (T) and potential energy (V) in terms of normal co-ordinates. T and V matrices: finding eigen-frequencies and eigen-vectors using these matrices. Normal modes of frequencies and normal coordinates. (15Lectures)

Two-body central force problem and H-J theory
Two body central force problem: Reduction to the equivalent one body problem, the equation of motion and first integrals, classification of orbits, the Virial theorem, the differential equation for the orbit, integrable power law in time in the Kepler's problem, H-J Theory: H-J equation and their solutions. (15 lectures)

Fluid Dynamics: Density ρ and pressure P in a fluid, an element of fluid and its velocity, continuity equation and mass conservation, stream-lined motion, laminar flow, Poiseuille‟s equation for flow of a liquid through a pipe. (10 Lectures)

COURSE OUTCOME

On successful completion of this course, students should be able to:

- Understand the Lagrangian and Hamiltonian formalisms so that they can apply these methods to solve real world problems.
- Understand the theory of small oscillations and concept of Poisson bracket.
- Understand the Two-body central force problem and H-J theory.
- Understand the multi-disciplinary topic 'Chaos' which will enable the students to learn non-linear dynamics.

REFERENCE BOOKS:

1. Classical Mechanics, H.Goldstein, C.P. Poole, J.L. Safko, 3 rdEdn. 2002,Pearson Education.
2. Mechanics, L. D. Landau and E. M. Lifshitz, 1976, Pergamon.
3. Classical Mechanics, P.S. Joag, N.C. Rana, 1st Edn., McGraw Hall.
4. Classical Mechanics, R. Douglas Gregory, 2015, Cambridge University Press.
5. Solved Problems in classical Mechanics, O.L. Delange and J. Pierrus, 2010, Oxford Press
6. Classical Mechanics, Tai L. Chow, CRC Press.
7. Classical Mechanics (3rd ed., 2002) by H. Goldstein, C. Poole and J. Safko
8. Classical Mechanics of particles and rigid bodies by K. C. Gupta