J.C. Bose University of Science & Technology, YMCA, Faridabad
(A Haryana State Government University)
(Established by Haryana State Legislative Act No. 21 of 2009 & Recognised by UGC Act 1956 u/s 22 to Confer Degrees)
Accredited 'A' Grade by NAAC

Date: 3/8/21

Department of Physics

Minutes of the 5th BOS meeting of the Department of Physics held on 27th July 2021 at 10.30 AM via online mode

The following members were present in the meeting:

1. Dr. Anuradha Sharma (Chairperson)
2. Prof. H.K. Malik (External member)
3. Prof. Sanjeev Agarwal (External member)
4. Dr. Amanpal Singh (External member)
5. Dr. Sonia Bansal (Member)
6. Dr. Maneesha Garg(Member)
7. Dr. Arun Kumar (Member)
8. Dr. Ompal Singh (Member)

Prof Tilak Raj could not attend the meeting. At the onset of the meeting, Dr. Anuradha Sharma, Chairperson, Department of Physics, welcomed members of the Board of Studies.

Item 5.1: To confirm the minutes of the 4th BOS meeting held on 06/07/2021.

Minutes of the meeting were confirmed by the BOS.

Item 5.2: To consider the modified syllabus of M.Sc. Physics with LOCF.

The modified syllabus containing LOCF was presented before the board. Sixteen new courses are introduced in MSc. Physics from the session 2021-2022. Minor modifications have also been done in 16 courses. Total percentage change in the syllabus is around 80%.

The BOS approves the revised syllabus applicable from the session 2021-2022 (Annexure 1).

Item 5.3: To consider the revised syllabus of B.Sc. (Hons.) Physics.

The B.Sc. syllabus was revised by an internal committee and placed in the workshop held on 20th July 2021. After approval from the workshop, the revised syllabus was putup in the BOS. The content of the syllabus which is 30% (23 out of total 78 courses) of the original content is approved by the board (Annexure2).

Item 5.4: To consider the minutes of 10th DRC meeting to be held on 26th July 2021.

The minutes were approved by the BOS (Annexure 3).

Item 5.5: To consider the list of examiners for M.Sc. Physics, B.Sc. (Hons.) Physics and B.Tech. examinations.

List of examiner is approved by the BOS (Annexure 4).

ASharma

Chairperson

Department of Physics

CC: All concerned.

NEW COURSES INTRODUCED

M.Sc Physics

(BOS dated 27th July, 2021)

S.No.	Department	Program Name	Name of the Course	Course Code
1	Physics	M.Sc. Physics	Mathematical Physics	MPH101
2	Physics	M.Sc. Physics	Classical Mechanics	MPH102
3	Physics	M.Sc. Physics	Quantum Mechanics-I	MPH103
4	Physics	M.Sc. Physics	Electronic Devices	MPH104
5	Physics	M.Sc. Physics	Physics Laboratory-I	MPH105
6	Physics	M.Sc. Physics	Seminar-I	MPH106
7	Physics	M.Sc. Physics	Quantum Mechanics - II	MPH201
8	Physics	M.Sc. Physics	Nuclear and Particle Physics	MPH202
9	Physics	M.Sc. Physics	Solid State Physics	MPH203
10	Physics	M.Sc. Physics	Electrodynamics	MPH204
11	Physics	M.Sc. Physics	Physics Laboratory-II	MPH205
12	Physics	M.Sc. Physics	Atomic and Molecular Physics	MPH301
13	Physics	M.Sc. Physics	Statistical Mechanics	MPH302
14	Physics	M.Sc. Physics	Laser Technology	MPH401
15	Physics	M.Sc. Physics	Materials Science	MPH402
16	Physics	M.Sc. Physics	Dissertation	MPH405
17	Physics	M.Sc. Physics	Nuclear Reactions	MPN303
18	Physics	M.Sc. Physics	Nuclear Detectors	MPN304
19	Physics	M.Sc. Physics	Nuclear Physics Spec. Lab	MPN305
20	Physics	M.Sc. Physics	Nuclear Models and Astrophysics	MPN403

21	Physics	M.Sc. Physics	Nuclear Techniques and Neutron Physics	MPN404
22	Physics	M.Sc. Physics	Materials Characterization Techniques	MPM303
23	Physics	M.Sc. Physics	Fundamentals and synthesis of nanomaterials	MPM304
24	Physics	M.Sc. Physics	Material Science Spec. Lab	MPM305
25	Physics	M.Sc. Physics	Advanced Materials Science	MPM403
26	Physics	M.Sc. Physics	Vacuum Science and Thin Films Technology	MPM404
27	Physics	M.Sc. Physics	Analog Electronics	MPE303
28	Physics	M.Sc. Physics	Microprocessor	MPE304
29	Physics	M.Sc. Physics	Electronics Spec. Lab	MPE305
30	Physics	M.Sc. Physics	Digital Electronics	MPE403
31	Physics	M.Sc. Physics	Optical fiber Communication	MPE404
32	Physics	M.Sc. Physics	RENEWABLE ENERGY RESOURCES	APH101
33	Physics	M.Sc. Physics	INTRODUCTION TO ASTROPHYSICS AND COSMOLOGY	OPH101
34	Physics	M.Sc. Physics	ENERGY HARVESTING AND STORAGE DEVICES	OPH102

NEW COURSES INTRODUCED

B.Sc.(H) Physics

(BOS dated 27th July, 2021)

S.No.	Department	Program Name	Name of the Course	Course Code
1	Physics	B.Sc. Physics	Mathematical Physics-I	BPH-101A
2	Physics	B.Sc. Physics	Mechanics	BPH-102A
3	Physics	B.Sc. Physics	Mathematical Physics-I Lab	BPH-103A
4	Physics	B.Sc. Physics	Mechanics Lab	BPH-104A
5	Physics	B.Sc. Physics	Electricity & Magnetism	BPH-201A
6	Physics	B.Sc. Physics	Waves & Optics	BPH-202A
7	Physics	B.Sc. Physics	Electricity & Magnetism Lab	BPH-203A
8	Physics	B.Sc. Physics	Waves & Optics Lab	BPH-204A
9	Physics	B.Sc. Physics	Mathematical Physics-II	BPH-301A
10	Physics	B.Sc. Physics	Thermal Physics	BPH-302A
11	Physics	B.Sc. Physics	Analog Systems & Applications	BPH-303A
12	Physics	B.Sc. Physics	Mathematical Physics-II Lab	BPH-304A
13	Physics	B.Sc. Physics	Thermal Physics Lab	BPH-305A
14	Physics	B.Sc. Physics	Analog Systems & Applications Lab	BPH-306A
15	Physics	B.Sc. Physics	Mathematical Physics-III	BPH-401A
16	Physics	B.Sc. Physics	Elements of Modern Physics	BPH-402A
17	Physics	B.Sc. Physics	Digital Systems &Applications	BPH-403A
18	Physics	B.Sc. Physics	Mathematical Physics-III Lab	BPH-404A
19	Physics	B.Sc. Physics	Elements of Modern Physics Lab	BPH-405A
20	Physics	B.Sc. Physics	Digital Systems & Applications Lab	BPH-406A

21	Physics	B.Sc. Physics	Computational Physics Skills	SECP-01A
22	Physics	B.Sc. Physics	Electrical Circuits & Network Skills	SECP-02A
23	Physics	B.Sc. Physics	Basic Instrumentation Skills	SECP-03A
24	Physics	B.Sc. Physics	Computational Physics Skills Lab	SECP-04A
25	Physics	B.Sc. Physics	Electrical Circuits & Network Skills Lab	SECP-05A
26	Physics	B.Sc. Physics	Basic Instrumentation Skills Lab	SECP-06A
27	Physics	B.Sc. Physics	Renewable Energy and Energy Harvesting	SECP-07A
28	Physics	B.Sc. Physics	Renewable Energy and Energy Harvesting Lab	SECP-08A
29	Physics	B.Sc. Physics	Quantum Mechanics & Applications	BPH-501A
30	Physics	B.Sc. Physics	Solid State Physics	BPH-502A
31	Physics	B.Sc. Physics	Quantum Mechanics & Applications Lab	BPH-503A
32	Physics	B.Sc. Physics	Solid State Physics Lab	BPH-504A
33	Physics	B.Sc. Physics	Atomic & Molecular Physics	DECP-501A
34	Physics	B.Sc. Physics	Experimental Techniques	DECP-502A
35.	Physics	B.Sc. Physics	Linear Algebra & Tensor Analysis	DECP-503A
36.	Physics	B.Sc. Physics	Experimental Techniques Lab	DECP-504A
37.	Physics	B.Sc. Physics	Biological & Medical Physics	DECP-505A
38.	Physics	B.Sc. Physics	Astronomy & Astrophysics	DECP-506A
39.	Physics	B.Sc. Physics	Electromagnetic Theory	BPH-601A
40.	Physics	B.Sc. Physics	Statistical Mechanics	BPH-602A
41.	Physics	B.Sc. Physics	Electromagnetic Theory Lab	BPH-603A
42.	Physics	B.Sc. Physics	Statistical Mechanics Lab	BPH-604A
43.	Physics	B.Sc. Physics	Nuclear & Particle Physics	DECP-601A
44.	Physics	B.Sc. Physics	Nano Materials & Applications	DECP-602A
45.	Physics	B.Sc. Physics	Physics of Devices & Communication	DECP-603A
46.	Physics	B.Sc. Physics	Nano Materials & Applications Lab	DECP-604A
47.	Physics	B.Sc. Physics	Physics of Devices & Communication Lab	DECP-605A

48.	Physics	B.Sc. Physics	Classical Dynamics	DECP-606A

M.Sc. Physics

Scheme and Syllabus

OUTCOME BASED EDUCATION SYSTEM (OBES)/

Learning Outcomes based Curriculum Framework (LOCF)

Choice Base Credit System (CBCS)

ACADEMIC SESSION

(w.e.f. 2021-2022)

DEPARTMENT OF PHYSICS

FACULTY OF SCIENCES

J C BOSE UNIVERSITY OF SCIENCE AND TECHNOLOGY, YMCA, FARIDABAD HARYANA -121006

J C BOSE UNIVERSITY OF SCIENCE AND TECHNOLOGY, YMCA

VISION

J C BOSE University of Science and Technology, YMCA 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

DEPARTMENT OF PHYSICS

VISION

A department that can effectively harness its 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.

PROGRAM NAME: 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. The program has following three specializations:

I Nuclear Physics
II Materials Science
III Electronics

Program Outcomes (POs) for Post Graduate Programs (CBCS) in the Faculty of Sciences, J.C. Bose University of Science and Technology, YMCA, Faridabad

PO1	Knowledge	Capable of demonstrating comprehensive disciplinary knowledge gained during course of study
PO2	Research Aptitude	Capability to ask relevant/appropriate questions for identifying, formulating and analyzing the research problems and to draw conclusion from the analysis

PO3	Communication	Ability to communicate effectively on general and scientific topics with the scientific community and with society at large
PO4	Problem Solving	Capability of applying knowledge to solve scientific and other problems
PO5	Individual and Team Work	Capable to learn and work effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings.
PO6	Investigation of Problems	Ability of critical thinking, analytical reasoning and research based knowledge including design of experiments, analysis and interpretation of data to provide conclusions
PO7	Modern Tool usage	Ability to use and learn techniques, skills and modern tools for scientific practices
PO8	Science and Society	Ability to apply reasoning to assess the different issues related to society and the consequent responsibilities relevant to the professional scientific practices
PO9	Life-Long Learning	Aptitude to apply knowledge and skills that are necessary for participating in learning activities throughout life
PO10	Ethics	Capability to identify and apply ethical issues related to one's work, avoid unethical behaviour such as fabrication of data, committing plagiarism and unbiased truthful actions in all

		aspects of work
PO11	Project Management	Ability to demonstrate knowledge and understanding of the scientific principles and apply these to manage projects

Program Specific Outcomes (PSOs)

After successful completion of M. Sc. Physics program, the students will

PSO1: Acquire an in-depth understanding and knowledge of the core areas of Physics encompassing mathematical physics, classical mechanics, quantum mechanics, electrodynamics, and statistical mechanics for explicating physical phenomena covering wide length and time scales.

PSO2: Be capable of applying the core physical laws to unravel a multitude of physical properties, processes, and effects involving radiation, nuclei, atoms, molecules, and bulk forms of matter.

PSO3: Develop hands-on skills for carrying out elementary as well as advanced experiments in different sub-fields of Physics viz. condensed matter physics, nuclear physics, particle physics, materials science, computational physics & electronics, along with enhancing their understanding of physical concepts and theories.

PSO4: Attain abilities of critical thinking, problem mapping & solving using fundamental principles of Physics, systematic analysis & interpretation of results, and unambiguous oral & writing/presentation skills.

PSO5: Have robust foundation in basic and practical aspects of Physics enabling them to venture into research in front-line areas of physical sciences, and career as Physics teachers and scientists.

J C BOSE UNIVERSITY OF SCIENCE AND TECHNOLOGY, YMCA, FARIDABAD
DEPARTMENT OF PHYSICS

SCHEME M.SC. PHYSICS

SEMESTER I

Subject Code	Title	L	T	P	Internal Assessment	End-semester Examination	Total	Credits	Category Code
MPH101	Mathematical Physics	4	0	0	25	75	100	4	DCC
MPH102	Classical Mechanics	4	0	0	25	75	100	4	DCC
MPH103	Quantum Mechanics-I	4	0	0	25	75	100	4	DCC
MPH104	Electronic Devices	4	0	0	25	75	100	4	DCC
MPH105	Physics Laboratory-I	0	0	16	30	70	100	8	DCC
MPH106	Seminar-I	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 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

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./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 the 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 the course coordinator and chairperson.

SEMESTER II

Subject Code	Title	L	T	P	Internal Assessment	End-sem Exam	Total	Credits	Category Code
MPH201	Quantum Mechanics - II	4	0	0	25	75	100	4	DCC
MPH202	Nuclear and Particle Physics	4	0	0	25	75	100	4	DCC
MPH203	Solid State Physics	4	0	0	25	75	100	4	DCC
MPH204	Electrodynamics	4	0	0	25	75	100	4	DCC
MPH205	Physics Laboratory-II	0	0	16	30	70	100	8	DCC

MPH206	Seminar-II	2	0	0	50		50	0	DCC
XXX	Audit Course*	2	0	0	25	75	100	2	AUD
Total Marks							**650**	**26**	

- DCC – Discipline Core Course; AUD-Audit Course; L – Lecture; P - Practical
- *provided by the Department/ University along with subject code and syllabus.
- *URL for various department OEC and Audit Courses https://jcboseust.ac.in/postgraduate-programmes

SEMESTER III

Subject Code	Title	L	T	P	Internal Assessment	End-sem Exam	Total	Credits	Category Code
MPH301	Atomic and Molecular Physics	4	0	0	25	75	100	4	DCC
MPH302	Statistical Mechanics	4	0	0	25	75	100	4	DCC
MPX303	*Specialization I/II/III	4	0	0	25	75	100	4	DEC
MPX304	Specialization I/II/III	4	0	0	25	75	100	4	DEC
MPX305	Specialization (I/II/III) Lab	0	0	16	30	70	100	8	DEC
MPH306	Seminar-III	2	0	0	50		50	0	DCC
XXX	**OEC/VAC	3	0	0	25	75	100	3	OEC
Total Marks							**650**	**27**	

- DCC – Discipline Core Course; * Students will have to choose one out three specializations offered by the department. The choice will be granted on merit basis **OEC – Open Elective Course; L – Lecture; T-Tutorial, P – Practical, **VAC- Value Added Course** URL for various department OEC and Audit Courses https://jcboseust.ac.in/postgraduate-programmes

SEMESTER IV

Subject Code	Title	L	T	P	Internal Assessment	End-semester Examination	Total	Credits	Category Code
MPH401	Laser Technology	4	0	0	25	75	100	4	DCC

MPH402	Materials Science	4	0	0	25	75	100	4	DCC
MPX403	*Specialization I/II/III	4	0	0	25	75	100	4	DEC
MPX404	*Specialization I/II/III	4	0	0	25	75	100	4	DEC
MPH405	#Dissertation	2	0	0	30	70	100	6	DCC
Total Marks							**500**	**22**	

- DCC – Discipline Core Course; DEC – Discipline Elective Course; L – Lecture; P - Practical
- * Students will continue with the same specialization as was chosen in Semester III.
- # Students will have to complete a dissertation in the respective specialization under the guidance of the supervisor. Formatting and description for dissertation writing will be provided.

Guidelines for Dissertation

The purpose of the dissertation in M.Sc. (Physics) 4th semester is to introduce research methodology to the students. It may consist of review of some research papers, development of a laboratory experiment, fabrication of a device, working out some problem related to Physics, participation in some ongoing research activity, analysis of data, etc. The work can be carried out in any thrust areas of Physics (Experimental or Theoretical Physics) under the guidance of faculty members of the department. The students must submit their dissertation in the department as per the date announced for the submission.

Internal assessment of the dissertation work will be carried out by respective faculty members assigned to them as mentor/supervisor through power point presentation given by candidates during the semester. External assessment of the dissertation work will be carried out by an external examiner (nominated by the Chairperson of the Department) through power-point presentation given by candidates. This load (equivalent to 2 hours per week) will be counted towards the normal teaching load of the teacher.

1. Dissertation will contain a cover page, certificate signed by student and supervisor, table of contents, introduction, methodology, result and discussion conclusion, and references.

- The paper size to be used should be A-4 size.
- The font size should be 12 with Times Roman font
- The text of the dissertation may be typed in 1.5 (one and a half) space.
- The print out of the dissertation shall be done on both sides of the paper (instead of single side printing)
- The total no. of writing pages should be between 40 to 60 for dissertation.

2. The candidate shall be required to submit two soft bound copies of dissertation along with a CD in the department as per the date announced.

3. Dissertation will be evaluated internally by the supervisor allotted to the student during the semester.

4. The candidate will defend her/his dissertation/project work through presentation before the External examiner at the end of semester and will be awarded marks.

5. In case, a student is not able to score passing marks in the dissertation exam, he/she will have to resubmit her/his dissertation after making all corrections/improvements & this dissertation shall be evaluated as above. The candidate is required to submit the corrected copy of the dissertation in hard bound within two weeks after the viva -voce.

List of Specialization Papers

Specialization-I: Nuclear Physics

Subject Code	Title	L	T	P	Internal Assessment	End-semester Examination	Total	Credits	Category Code
Semester III									
MPN303	Nuclear Reactions	4	0	0	25	75	100	4	DEC
MPN304	Nuclear Detectors	4	0	0	25	75	100	4	DEC
MPN305	Nuclear Physics Spec. Lab	0	0	16	30	70	100	8	DEC
Semester IV									
MPN403	Nuclear Models and	4	0	0	25	75	100	4	DEC

	Astrophysics								
MPN404	Nuclear Techniques and Neutron Physics	4	0	0	25	75	100	4	DEC

Specialization-II: Materials Science

Subject Code	Title	L	T	P	Internal Assessment	End-semester Examination	Total	Credits	Category Code
Semester III									
MPM303	Materials Characterization Techniques	4	0	0	25	75	100	4	DEC
MPM304	Fundamentals and synthesis of nanomaterials	4	0	0	25	75	100	4	DEC
MPM305	Material Science Spec. Lab	0	0	16	30	70	100	8	DEC
Semester IV									
MPM403	Advanced Materials Science	4	0	0	25	75	100	4	DEC
MPM404	Vacuum Science and Thin Films Technology	4	0	0	25	75	100	4	DEC

Specialization-III: Electronics

Subject Code	Title	L	T	P	Internal Assessment	End-semester Examination	Total	Credits	Category Code

Semester III									
MPE303	Analog Electronics	4	0	0	25	75	100	4	DEC
MPE304	Microprocessor	4	0	0	25	75	100	4	DEC
MPE305	Electronics Spec. Lab	0	0	16	30	70	100	8	DEC
Semester IV									
MPE403	Digital Electronics	4	0	0	25	75	100	4	DEC
MPE404	Optical fiber Communicatio n	4	0	0	25	75	100	4	DEC

The Audit course and Open elective courses offered by Department of Physics for PG students are as follows:

Course	Subject	Subject Code	NO OF CREDITS
AUDIT COURSE	RENEWABLE ENERGY RESOURCES	APH101	2
OEC	INTRODUCTION TO ASTROPHYSICS AND COSMOLOGY	OPH101	3
	ENERGY HARVESTING AND STORAGE DEVICES	OPH102	3

- ❖ The students have to choose one Audit course (0 credit) from the list provided by the department/University. Only passing of the Audit course will be mandatory.
- ❖ The students have to choose one Open Elective Course (03 credits) related to other branch of Science/Engineering/other discipline required for enhancing professional performance as provided by the department/university.

JC BOSE UNIVERSITY OF SCIENCE AND TECHNOLOGY, YMCA, FARIDABAD

DEPARTMENT OF PHYSICS

SYLLABI OF M.SC. PHYSICS

M.Sc. PHYSICS SEMESTER-I

MPH101

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 2 marks each. It should cover the entire syllabus. Part II will consist of six questions of 10 marks each out of which the student has to attempt any four.

Course Outcomes (COs)

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

MPH101.1 *Derive Cauchy integral theorem and Cauchy integral formula and find Taylor and Laurent series expansion of functions of complex variable.*

MPH101.2 *Understand the calculus of residue and evaluate some typical definite integral using the method of contour integration.*

MPH101.3 *Find explicit expressions of Hermite, Laguerre, Bessel and Legendre polynomials using the corresponding generating functions and derive orthogonality relations and various recurrence relations among these special functions for their applications in solving quantum mechanical systems.*

MPH101.4 *Apply the knowledge of matrices for solving linear algebraic equations and Learn basics of group theory and prepare group multiplication tables for understanding crystallography.*

MPH101.5 *Learn properties of Fourier and Laplace transforms and evaluate the Fourier and Laplace transforms of functions and derivatives.*

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 $P_n(x)$; 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, 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 Laplacetransform, Transform of Derivatives, Transform of Integrals, Convolution theorem, and its applications, Inverse Laplace Transform by partial fractions method

REFERENCE BOOKS:
1. Mathematical methods for Physicists, Arfken, 4th edition, Academic Press Inc. 1995.

3. Mathematical Physics, AK Ghatak, Trinity Press-Laxmi Publications, 1st Edition, 1995.
4. Mathematical Physics by H.K. Dass, S. Chand Publications, 5th edition, 2017.
5. Schaum's Outlines Complex Variables by M. R. Spiegel, Mc-Graw hill publications, 2015.
6. Group theory and Quantum Mechanics by M. Tinkam, Dover Publications, 2012.
7. Schaum's Outlines Group Theory by B. Baumslag, B. Chandler, Mc-Graw Hills, 2012.

SUGGESTED WEB SOURCES:

1. https://nptel.ac.in/courses/103/106/103106162/
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

CO-PO matrix for the course MPH101 (Mathematical Physics)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4	PSO5
MPH 101.1	3	2	2	3	2	3	3	3	3	2	3	3	2	1	2	2
MPH101.2	3	2	2	3	2	3	3	3	3	2	3	3	1	1	3	3
MPH101.3	3	2	2	3	2	3	3	3	3	2	2	3	2	1	2	2
MPH101.4	3	2	2	3	2	3	3	3	3	2	3	3	2	1	2	3
MPH101.5	3	2	2	3	2	3	3	3	3	2	3	3	2	1	2	3
Average	3	2	2	3	2	3	3	3	3	2	3	3	2	1	2.2	2.8

M.Sc. PHYSICS SEMESTER-I

MPH102

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 OUTCOME: On successful completion of classical Mechanics, students should be able to:

MPH102.1	*Demonstrate a basic and advanced knowledge of Lagrangian and Hamiltonian Formulations and solve related problems.*
MPH102.2	*Identify the cyclic coordinates and understand their importance in Hamiltonian formulation.*
MPH102.3	*Acquire knowledge of Poisson and Lagrange Brackets and establish relationships between their properties.*
MPH102.4	*Demonstrate the concept of motion of a particle under central force and apply advanced methods to deal with central force problems.*
MPH102.5	*Use Hamilton-Jacobi theory for finding the solutions of various Classical systems.*
MPH102.6	*Develop a deep understanding to tackle the problems of small oscillations and special theory of relativity.*

Unit I: Lagrangian and Hamiltonian Formulations (12 hrs.)
Types of Constraints on dynamical systems, Generalized Coordinates Hamilton's principle, Derivation of Lagrange's equations from Hamilton's principle, Principle of Least Action and its applications, Canonical Transformation, Legendre Transformation and Hamilton's equation of motion, The physical significance of the Hamiltonian, Cyclic coordinates, Applications of Langrangian and Hamiltonian Formulation.

Unit II: Poisson and Lagrange Brackets (12 hrs.)
Poisson bracket and its properties, Poisson theorem, Poisson bracket and canonical transformation, Jacobi identity and its derivation, Lagrange bracket and its properties, Relationship between Poisson and Lagrange brackets and its properties, Liouville's theorem and its applications.

Unit III: Central Force Problem and Hamilton-Jacobi Theory (12 hrs.)

Two body central force problem: Reduction to the equivalent one-body problem, Equation of motion and first integrals, Classification of orbits, Virial theorem, Differential equation for the orbit, Integrable power law in time in the Kepler's problem,
Hamilton-Jacobi Theory: Hamilton-Jacobi equation, Separation of variables in Hamilton-Jacobi equation. Solution of Harmonic Oscillator problem and Kepler's Problem by Hamilton-Jacobi Method.

Unit IV: Small Oscillations and Special Theory of Relativity (12 hrs.)

Theory of small oscillations: Formulation of the problem, Eigenvalue equation, and the principle axis transformation, Frequencies of free vibrations and Normal coordinates, Free vibrations of a linear triatomic molecule.
Special Theory of Relativity: Postulates of Special Theory of Relativity, Lorentz Transformation, Length Contraction, Time Dilation, Relativistic addition of velocities, variation of mass with velocity, mass-energy equivalence.

REFERENCE BOOKS:

1. Classical Mechanics (3rd ed., 2002), H. Goldstein, C. Poole, and J. Safko, Addison Wesley.
2. Classical Mechanics, J C Upadhyaya, Himalaya Publishing House.
3. Classical Mechanics, G. Aruldhas, PHI Learning Pvt. Ltd., New Delhi.
4. Classical Mechanics, John R. Taylor, University Science Books, USA.

SUGGESTED WEB SOURCES:

1. https://nptel.ac.in/courses/103/106/103106162/
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

CO-PO matrix for the course MPH102 (Classical Mechanics)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4	PSO5
MPH 102.1	3	2	2	3	3	3	2	3	3	3	3	3	3	3	3	2
MPH 102.2	3	3	2	3	3	3	2	3	2	2	3	3	2	2	3	3

MPH 102.3	3	3	2	3	3	3	2	3	3	3	2	3	2	2	3	2
MPH 102.4	3	3	2	3	2	3	3	3	3	3	3	3	2	1	2	2
MPH 102.5	3	3	1	3	2	3	2	2	2	3	2	3	2	1	3	2
MPH 102.6	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3
Average	3	2.83	2	3	2.67	3	2.33	2.83	2.67	2.83	2.67	3	2.33	1.83	2.83	2.33

M.Sc. PHYSICS SEMESTER-I

MPH103

SUBJECT NAME: QUANTUM MECHANICS - I

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 Outcomes (COs)

After successful completion of the course on Quantum Mechanics - I, a student will be able to:

MPH103.1 *Realize the basic quantum-mechanical view point, and learn its wave mechanical formulation for a non-relativistic situation, Solve the 3 dimensional Schrödinger wave equation for eigenfunctions and eigenvalues for harmonic oscillator and Hydrogen atom.*

MPH103.2 *Construct matrices for observables and wave functions in different representations, and apply the matrix theory for calculating eigenvalues and eigenfunctions*

MPH103.3 *Describe the time-development of a quantum system in Schrödinger, Heisenberg and Interaction pictures, and to envisage the same in Hilbert space.*

MPH103. *Calculate the eigenvalues and eigenfunctions for the orbital and*

4	*general angular momenta, along with the matrix representation of angular momentum.*
MPH103. 5	*Have an understanding of the perturbation theory and apply the same for degenerate and non-degenerate systems.*
MPH103. 6	*Apply the time-dependent perturbation theory to deal with atom-em radiation interaction and calculate explicitly the transition probability for the induced absorption and emission processes.*

UNIT-I: Fundamentals of Quantum Mechanics (12hrs)

Need of Quantum Mechanics, Two slit experiment with radiation and matter particles, Ehrenfest theorem, Postulates of quantum mechanics, Wave function and Schrödinger wave equation, Orthonormality of eigenfunctions, Reality of eigenvalues, Closure property, Probability density, Expectation values, Uncertainty principle for two arbitrary observables, Solution of Schrödinger equation for three dimensional problems: Harmonic oscillator, Hydrogen atom Problem (radial wave functions and energy eigenvalues).

UNIT-II: Matrix formalism of Quantum Mechanics (12hrs)

Overview of Linear Vector Space, Basis, Operators, Dirac Notations of Bra and Ket, Matrix Representation of Observables and States, Determination of Eigenvalues and Eigenfunctions of Observables, orthogonality, closure, completeness. Matrix theory of the harmonic oscillator: Spectrum of eigenvalues and eigenfunctions, Hilbert space representation, Change of Representation, Hermitian and Unitary Transformation, Time-development of quantum system: Schrödinger, Heisenberg and Interaction pictures

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

Orbital angular momentum operator $\mathbf{L}$, Cartesian and spherical polar coordinate representation, Commutation Rules for Angular Momentum, Eigenvalues and Eigenfunctions of $\mathbf{L^2}$ and $\mathbf{L_z}$, General angular momentum operator $\mathbf{J}$, Eigenvalues and Eigenfunctions of $\mathbf{J^2}$ and $\mathbf{J_z}$ Matrix Representation of Angular Momentum Operators, Spin angular momentum, Wavefunction including spin (Spinor), Spin one half: Spin eigenfunctions and Pauli Spin Matrices.

UNIT-IV: Perturbation Theory (12hrs)

Perturbation Theory of Non-degenerate Systems with first and second order corrections to energy eigenvalues and eigenfunctions, Application to He Atom, Zeeman Effect without electron spin, Perturbation Theory for Degenerate Systems, First order correction, First Order Stark Effect in H-Atom, Time Dependent

Perturbation Theory (First Order), Transition probability for constant and harmonic perturbations, Fermi Golden Rule.

REFERENCE BOOKS:

1. Quantum Mechanics by L. I. Schiff, McGraw-Hill Education
2. Quantum Mechanics - A Modern Introduction by A. Das and A. C.Melissinos, Gordan and Breach Science Publishers
3. Modern Quantum Mechanics by J. J. Sakurai, Pearson publishers.
4. Principles of Quantum Mechanics by P. Dirac, Oxford University Press.
5. Principles of Quantum Mechanics by R. Shankar, Plenum Press.
6. Quantum Mechanics by A. K. Ghatak & S. Lokanathan, Kluwer Publications.

SUGGESTED WEB SOURCES:

1. https://nptel.ac.in/courses/103/106/103106162/
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

CO-PO matrix for the course MPH103 (Quantum Mechanics-I)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4	PSO5
MPH103.1	3	3	2	3	3	3	2	3	3	3	3	3	2	2	3	2
MPH103.2	3	3	3	3	3	3	2	3	3	3	2	3	2	2	3	2
MPH103.3	3	3	3	3	3	3	2	2	3	2	2	3	1	1	2	2
MPH103.4	3	2	2	3	3	3	3	2	2	3	3	3	2	2	3	3
MPH103.5	3	3	3	2	2	3	2	2	2	2	2	3	3	2	3	2
MPH103.6	3	3	2	3	2	3	2	3	3	3	2	3	3	3	3	3
Average	3	2.83	2.5	2.83	2.67	3	2.17	2.5	2.67	2.67	2.34	3	2.167	2	2.83	2.33

M.Sc. PHYSICS SEMESTER-I

MPH 104

SUBJECT NAME: ELECTRONIC DEVICES

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 2 marks each. It should cover the entire syllabus. Part II will consist of six questions of 10 marks each out of which the student has to attempt any four.

COURSE OUTCOMES:

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

MPH104.1 Understand the fabrication process for devices and ICs like crystal growth, Oxidation, pattern transfer, diffusion, etching, ion-implantation and epitaxial growth.

MPH104.2 Gain Knowledge of inter-connection, packaging and the processing of compound semiconductor.

MPH104.3 Obtain a fair understanding of the steps involved in the fabrication of electronic devices like BJT, MOSFET, FET, Schottky diodes IC diodes capacitors and resistors.

MPH104.4 Gain a fair understanding of the operation and application of decoders, multiplexers, encoders and flip-flops.

MPH104.5 Comprehend the operation and application of RAMs, ROMs, 555 IC timer, D/A and A/D Converters.

MPH104.6 Explain operation and important adders, shift resistor and Counters.

Unit I: 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 II: 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 and MOSFET.

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.

REFERENCE BOOKS:

1. Integrated Electronics by jacob millman and christos c halkias, Mcgraw Hill Higher Education, (1 January 2002)
2. Gayakwad: OP-AMPS and Linear Integrated Circuits , 4th Edition, Prentice Hall / Pearson.
3. Jacob Millman and Arvin Grabel: Microelectronics, McGraw Hill Education; 2nd edition (1 July 2017)

SUGGESTED WEB SOURCES:

1. https://nptel.ac.in/courses/103/106/103106162/
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

CO-PO matrix for the course MPH104 (Electronic Devices)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4	PSO5

MPH104.1	3	3	2	3	3	3	2	3	3	3	3	3	2	2	3	2
MPH104.2	3	3	3	3	3	3	2	3	3	3	2	3	2	2	3	2
MPH104.3	3	3	3	3	3	3	2	2	3	2	2	3	1	1	2	2
MPH104.4	3	2	2	3	3	3	3	2	2	3	3	3	2	2	3	3
MPH104.5	3	3	3	2	2	3	2	2	2	2	2	3	3	2	3	2
MPH104.6	3	3	2	3	2	3	2	3	3	3	2	3	3	3	3	3
Average	3	2.83	2.5	2.83	2.67	3	2.17	2.5	2.67	2.67	2.34	3	2.167	2	2.83	2.33

M.Sc. PHYSICS SEMESTER-I

MPH105

SUBJECT NAME: PHYSICS LAB I

NO OF CREDITS: 8

SESSIONAL: 30

L	P		
0	16	END SEM EXAM:	70
		TOTAL:	100

Course Outcomes (COs)

After successful completion of creative work about 'Lab Experiments', student will be able to learn

MPH105.1 *Designing and working of diodes, transistors, and their applications.*

MPH105.2 *Build a common emitter/base/collector amplifier and measure its voltage gain.*

MPH105.3 *Understand the use of CRO for various applications.*

MPH105.4 *Explore the operation and advantages of operational amplifiers*

MPH105.5 *Learn to design different types of filters and apply the same to oscillators and amplifiers.*

MPH105.6 *Learn and understand about different types of IC's.*

MPH105.7 *Exploring the circuitry which converts an analog signal to a digital signal.*

MPH105.8 *Understand fundamentals of various physical phenomena and physical concepts*

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

Section A: Electronics Lab

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

SECTION B: General Physics lab

1. To verify the existence of different harmonics and measure their relative amplitudes in a complex wave using CRO (square, clipped sine wave, triangular wave, etc.)
2. Determination of Energy Band Gap of Silicon, Germanium, etc. using light-emitting diodes (LED's).
3. Demonstration of energy quantization using the Franck-Hertz Experiment
4. To determine wavelength, spot size, a divergence of LASER, Power distribution within the beam, Grating element of the grating.
5. To determine the wavelength of laser light using Michelson interferometer experiment.
6. To study the Magnetostriction effect in a metallic rod.
7. To determine the charge to mass ratio of an electron by using Magnetron.

8. To determine the Dielectric constant of dielectric material by varing frequency.
9. To find out the g-value using Electron spin resonance(ESR).
10. UJT – Characteristics, and its application as a relaxation oscillator.
10. SCR – Characteristics and its application as a switching device.

Note: More experiments may be added from time to time as per the requirement.

SUGGESTED WEB SOURCES:

1. https://nptel.ac.in/courses/103/106/103106162/
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

CO-PO matrix for the course MPH105 (Physics Lab I)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4	PSO5
MPH102.1	3	2	2	3	3	3	2	3	3	3	3	3	3	3	3	2
MPH102.2	3	3	2	3	3	3	2	3	2	2	3	3	2	2	3	3
MPH102.3	3	3	2	3	3	3	2	3	3	3	2	3	2	2	3	2
MPH102.4	3	3	2	3	2	3	3	3	3	3	3	3	2	1	2	2
MPH02.5	3	3	1	3	2	3	2	2	2	3	2	3	2	1	3	2
MP 102.6	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3
Average	3	2.83	2	3	2.67	3	2.33	2.83	2.67	2.83	2.67	3	2.33	1.83	2.83	2.33

M.Sc. PHYSICS SEMESTER-II

MPH201

SUBJECT NAME: QUANTUM MECHANICS II

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 A will consist of 10 short answer type questions of 1.5 marks each. It should cover the entire syllabus. Part B will consist of five questions of 15 each out of which the student has to attempt any four.

Course Outcomes (COs)

After successful completion of the course on Quantum Mechanics - II, a student will be able to:

MPH201.1 Use the WKB method to understand tunneling through a barrier and spherically symmetric potentials

MPH201.2 Perform quantum-mechanical addition of two general angular momenta, and calculate Clebsch-Gordan coefficients for some simple situations.

MPH201.3 Grasp the concepts of identity, indistinguishability, and see how eigenstates of a system of identical particles bifurcate into totally symmetric and anti-symmetric ones.

MPH201.4 Find the spin and total wave functions for a system of two identical spin ½ particles, and comprehend connection among spin, symmetry and statistics of identical particles.

MPH201.5 Have an understanding of the basics of non-relativistic quantum scattering theory, learn the theory of partial waves, calculate and analyse Born scattering cross-sections for finite square well and screened Coulomb potentials.

MPH201.6 Have knowledge of basic laws of relativistic quantum mechanics and ability to solve Klein - Gordan equation and Dirac equation.

Unit I: WKB approximation and Addition of Angular Momentum: (12hrs)

The WKB Approximation: The WKB solutions, The connection formulae and their derivation, Application of the WKB solutions to (i) eigenvalue problems, (ii) the tunnelling probability calculations and (iii) spherically symmetric potentials, Addition of two angular momenta, Clebsch-Gordan coefficients, their properties and calculation for $j_1 = j_2 = 1/2$, $j_1 = 1$, $j_2 = 1/2$ and $j_1 = j_2 = 1$.

Unit II: Identical Particles (12hrs)

Introduction, The principle of indistinguishability, Symmetrical and Antisymmetric wave function, Symmetrization postulate, Particle Exchange operator, Distinguishability of Identical particles, Connection among spin, symmetry and statistics of identical particles, Fermions and bosons; Spin and total wave functions for a system of two spin ½ particles, The Pauli's Exclusion principle, Slater determinant, Application to Helium atom, para- and ortho- Helium.

UNIT-III: Scattering (12hrs)

Laboratory and center of mass frame, Scattering amplitude, Differential scattering cross section and total scattering cross section, The optical theorem, Scattering by Spherically symmetric potential, Theory of Partial Wave and Calculation of Phase Shifts in Simple Cases, Integral Form of Scattering Equation, The first Born approximation, Scattering of an electron by a screened Coulomb potential in Born approximation and validity criterion. Scattering of identical Particles.

Unit IV: Relativistic Quantum Mechanics (12hrs)

Klein Gordon Equation and its interpretation , Klein Gordon equation in Electromagnetic field, Dirac's relativistic equation, Dirac Matrices, Covariant form of Dirac Equation, Charge and Current Densities, Electromagnetic potentials: Magnetic moment of the electron, Dirac equation for a central field, The Hydrogen atom, Negative energy solution, Anti-particles.

REFERENCE BOOKS:

1. Quantum Mechanics: John. L. Powell & Bernd Crasemann, Narosa Publishing House.
2. Quantum Mechanics Concepts and Applications: Nouredine Zettili, Wiley(Second Edition).
3. Quantum Mechanics : A.P.Messiah, Dover Publications.
4. Modern Quantum Mechanics : J.J.Sakurai, Cambridge University Press.
5. Quantum Mechanics-Theory And Applications : Ajoy Ghatak, S Lokanathan, Laxmi Publications.

SUGGESTED WEB SOURCES:

1. https://nptel.ac.in/courses/103/106/103106162/
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

CO-PO matrix for the course MPH201 (Quantum Mechanics-II)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4	PSO5
MPH201.1	3	2	2	3	3	3	2	3	2	2	2	3	2	2	3	2
MPH201.2	3	3	3	3	3	3	2	3	3	3	3	3	2	2	3	2
MPH201.3	3	3	3	2	2	3	3	3	2	2	2	3	1	1	2	2
MPH201.4	3	2	3	2	2	3	3	2	3	3	2	3	2	2	3	3
MPH201.5	3	1	2	3	3	3	2	3	2	2	3	3	3	2	3	2
MPH201.6	3	2	3	2	3	3	2	2	2	3	2	3	3	3	3	3
Average	3	2.17	2.67	2.5	2.67	3	2.34	2.67	2.34	2.5	2.34	3	2.167	2	2.83	2.33

M.Sc. PHYSICS SEMESTER-II

MPH202

SUBJECT NAME: NUCLEAR AND PARTICLE PHYSICS

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 Outcomes (COs)

After successful completion of the course on Nuclear and Particle Physics, a student will be able to:

MPH202.1 *Understand the energy loss processes of different energetic particles in a medium and mechanisms of interaction of gamma photon with matter.*

MPH202.2 *Learn about the basic properties and characteristics of Nuclear forces, and their mediating particle.*

MPH202.3 *Know and learn about various type of detectors used in nuclear physics experiments, unique properties of different detectors and their applications in the field of nuclear physics.*

MPH202.4 *Differentiate between different types of nuclear reactions, relevant aspects associated with nuclear reactions and kinematics of such reactions.*

MPH202.5 *Describe certain properties associated with nuclei, models governing different aspects of nuclear behaviour and detailed understanding of the deuteron problem.*

MPH202.6 *Understand the phenomenon of radioactive decays of alpha and beta particles, their detailed formalism.*

MPH202.7 *Know about different elementary particles, their quark content and quark model.*

MPH202.8 *Learn about decay of some elementary particles and laws governing such decays.*

Unit I: Nuclear Properties and Nuclear decay (12 hrs)

Properties of Nuclei (Charge, Mass, size, binding energy, spin, parity), Basic parameters of radioactivity (Decay constant, Activity, Half-life, Average life time), Laws of radioactive decay (Soddy-Fajans, radioactive disintegration and successive transformation), Types of decay: Alpha decay (Properties, charge to mass ratio, range, Geiger Nuttall law, energy, Gamow's Theory of Alpha-Decay), Beta decay (Types, energetics, Fermi's Theory of Beta-Decay), Neutrino theory: origin of continuous beta spectrum, and Gamma decay (Energetics of Gamma decay, selection rules), Internal conversion.

Unit II: Nuclear Forces and Models (12 hrs)

Properties of nuclear forces, Deuteron problem (Binding energy, spin parity, magnetic dipole moment, electric quadrupole moment); Nucleon-nucleon scattering (General formalism) neutron-proton scattering at low energies (Partial wave analysis, scattering length and effective length); proton-proton scattering at low energies. Types of Nuclear Models, liquid drop model (Basics, semi empirical mass formula, Binding energy, Asymmetry energy, Odd-Even effect) Shell model (Basics, success and failure), Unified model (General Idea).

Unit III: Interaction of Radiation with Matter and Nuclear Detectors (12 hrs)

Types of Nuclear Radiations and their interaction processes, Interaction of light charged Particles, Interaction of heavy charged Particles (Bohr's formula for Stopping power of heavy charged particles, Bethe-Bloch relation, Range and Straggling), Interaction of Gamma-Rays (Photoelectric effect, Compton effect and Pair production), Absorption of gamma rays and its applications, linear and mass absorption coefficients of gamma rays. Neutron interaction (basic concepts), classification of detectors on basis of interaction and operation. Construction and working of Gas filled detectors, Ionization chambers, Proportional counters (MWPC), GM counter.

Unit IV: Particle Physics (12 hrs)

Classification and properties of elementary particles, Fundamental interactions, conservation laws (Energy, charge, mass, angular momentum and linear momentum) and properties of elementary particles, Gell-Mann Nishijima Scheme, SU(2) and SU(3) symmetries, Properties of quarks and their classifications.

REFERENCE BOOKS:

1. Nuclear Physics by D.C. Tayal., (Himalaya Publishing House, 2009)
2. Introductory Nuclear Physics. By Kenneth S. Krane. (John Wiley & Sons, 1989)
3. Fundamentals of Nuclear physics by Jahan Singh (Pragati Prakashan)
4. Theory of Nuclear Structure by M. K. Pal (Affiliated East-West Press,1982).
5. Nuclear Reaction and Nuclear Structure by P.E. Hodgson (Clarendon Press, 1971)
6. Nuclear Physics by R. Prasad, (Pearson, 2014)

SUGGESTED WEB SOURCES:

1. https://nptel.ac.in/courses/103/106/103106162/
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

CO-PO matrix for the course MPH202 (Nuclear and Particle Physics)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4	PSO5
MPH202.1	3	3	3	3	3	3	2	3	3	2	3	3	3	2	3	3
MPH202.2	3	3	3	3	2	3	2	3	3	2	3	3	3	3	3	3
MPH202.3	3	3	3	3	2	3	2	2	3	2	2	3	3	3	3	3
MPH202.4	3	3	3	3	2	3	2	2	3	2	2	3	3	3	3	3
MPH202.5	3	3	2	3	2	3	2	2	3	2	3	3	3	3	2	2
MPH202.6	3	3	2	3	2	3	2	2	3	2	2	3	3	3	2	2
MPH202.7	3	3	2	3	2	3	2	2	3	2	2	3	2	2	2	2
MPH202.8	3	3	2	3	1	3	2	2	3	2	1	3	2	2	3	2
Average	3	3	2.5	3	2	3	2	2.25	3	2	2.25	3	2.75	2.63	2.63	2.5

M.Sc. PHYSICS SEMESTER-II

MPH203

SUBJECT NAME: SOLID STATE 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 2 marks each. It should cover the entire syllabus. Part II will consist of six questions of 10 marks each out of which the student has to attempt any four.

MPH203.1 *Analyze the structure of a crystalline solid in terms of lattice, basis, unit cell, reciprocal lattice, Brillouin zone and symmetry elements.*

MPH203.2 *Deduce the structure of a crystalline solid from an analysis of the XRD pattern and the theoretically calculated crystal structure factor.*

MPH203.3 *Calculate the dispersion of lattice waves for crystals with mono- and diatomic basis, and understand the principle underlying its experimental measurement using neutron scattering.*

MPH203.4 *Acquire an understanding of the concept of phonon and use it to determine the lattice heat capacity in the Einstein and Debye models.*

MPH203.5 *Learn Bloch's theorem, its application to the KP model, solve the one-electron Schrödinger equation for a periodic potential to see the emergence of energy bands, and classify materials into conductors, semiconductors and insulators.*

MPH203.6 *Learn and apply the tight binding and Wigner-Seitz methods for calculating the energy bands.*

Unit I: Symmetry and Reciprocal Lattice (12 hrs.)
Crystal symmetry elements, Miller indices, Direct lattice type, fundamental type of direct lattices i.e. 2 dimensional and 3 dimensional lattice, Diffraction of Waves by Crystal: The Bragg law, Fourier Analysis, Reciprocal lattice Vectors, Diffraction Condition. Brillouin Zones, Reciprocal lattice (example of sc, bcc, fcc, hcp lattices), Crystal structure factor (bcc, fcc), Atomic form factor, Scattering factors, Intensity of diffraction maxima, extinction due to lattice centering.

Unit II: Lattice Vibration (12 hrs.)
The concept of lattice modes of vibration, Elastic vibrations of continuous media, Vibration of one dimensional monoatomic and diatomic linear lattice, Particle displacement in two branches, Wavelength limit of acoustic phonons, Quantization of lattice waves: Phonons, Phonon momentum, Inelastic scattering of photons and phonons, Inelastic scattering of X rays by phonons, Inelastic scattering of neutrons by phonons, Electron-Electron Interaction, Electron-Phonon Interaction: Polarons.

Unit III: Electronic Properties of Solids (12 hrs.)

Electrons in periodic potential, Kronig-Penny model for band theory, brillouin 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: Fermi Surfaces and Metals (12 hrs.)

Reduced Zone Scheme, Periodic Zone Scheme, Construction of Fermi Surfaces: Tight Binding Method of Energy Bands: Wigner-Seitz Method, Cohesive Energy. Pseudopotential Methods, Experimental Methods in Fermi Surface Studies, Quantization of Orbits in a Magnetic Field, De Haas-van Alphen Effect, Fermi Surface of Copper, Magnetic Breakdown, Quantum Hall effect.

REFERENCE BOOKS:

1. C. Kittel, Introduction to Solid State Physics. 7th ed., Wiley, 1996
2. Adrianus J. Dekker., Solid State Physics. Front Cover. Prentice-Hall, 1957
3. SM Sze, Physics of semiconductor devices, 2nd ed. New york, Wiley, 1981
4. SO Pillai, Solid State Physics, New Academic Science Ltd; 6th edition (30 October 2009)

SUGGESTED WEB SOURCES:

1. https://nptel.ac.in/courses/103/106/103106162/
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

CO-PO matrix for the course MPH 203 (Solid State Physics)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4	PSO5
MPH203.1	3	3	1	3	2	3	2	1	1	2	2	3	2	1	2	2
MPH203.2	3	3	1	3	2	3	2	1	1	2	1	3	2	1	3	3
MPH203.3	3	3	1	2	2	3	2	1	1	2	2	3	2	1	2	2
MPH203.4	3	2	1	2	2	2	2	1	1	2	1	3	2	1	2	3

MPH203.5	3	3	1	3	2	3	2	1	1	2	2	3	2	1	2	3
MPH203.6	3	2	1	2	2	2	2	1	1	2	1	3	2	1	2	3
Average	3	2.66	1	2.5	2	2.66	2	1	1	2	1.5	3	2	1	2	3

M.Sc. PHYSICS SEMESTER-II

MPH204

SUBJECT NAME: ELECTRODYNAMICS

NO OF CREDITS: 4

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

Note: The question paper will be of two parts. Part I will consist of 10 questions of 2 marks each. It should cover the entire syllabus. Part II will consist of six questions of 10 marks each out of which the student has to attempt any four.

Course Outcomes (COs)

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

MPH204.1 *Enhance skills for solving Boundary value problems especially using Method of images.*

MPH204.2 *Understand the fundamental concepts of electrodynamics and describe the propagation of electromagnetic waves through different media.*

MPH204.3 *Understand the laws of reflection and transmission of electromagnetic waves at the interfaces of different media for normal and oblique incidence.*

MPH204.4 *Learn the basic concepts of dispersion and scattering of electromagnetic waves through different media.*

MPH204.5 *Understand the Non-uniqueness of Electromagnetic potentials with concept of Gauge and get familiarize with concept of retarded time for charges undergoing acceleration and evaluate fields and power corresponding to Lienard-Wiechert Potentials.*

MPH204.6 *Understand the basic concepts of Plasma Physics and wave guides and propagation of electromagnetic waves through plasma and through rectangular waveguide.*

Unit I: Introduction to Electrodynamics (12 hrs.)

Electrostatics: Method of Images, Point charge near an infinite Grounded Conducting Plane, Point charge in the presence of Grounded Conducting Sphere, Point charge in the presence of Charged, Insulated Conducting sphere, Point charge near a Conducting Sphere held at Fixed Potential, Conducting sphere in a Uniform Electric Field.
Electrodynamics: Energy stored in an electric and magnetic field. Continuity Equation, Displacement Current, Maxwell's equations, power flow in an electromagnetic field and poynting 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 lossless 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.
Dispersion and Scattering:- Radiative reaction force, Abraham Lorentz formula, scattering and absorption of radiation, Thompson scattering and Rayleigh Scattering, 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 time, Retarded potentials, Lienard-Wiechart potentials for a point charge, the potentials and fields of a charged particle moving with variable velocity and constant velocity, 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, Debye Shielding, Plasma Parameters, applications of Plasma, EM Wave propagation through plasma. Plasma production and heating of the plasma.

Waveguides:- Maxwell's equations in waveguides, TE, TM and TEM waves, TE and TM modes in rectangular waveguides, concept of cut-off frequency, dielectric waveguides.
Polarization of electromagnetic waves:-Linear, elliptical and circular Polarization

REFERENCE BOOKS:
1.Classical Electrodynamics by J.D. Jackson, John Wiley & Sons, New York, 1962.
2. Introduction to Electrodynamics by D. J. Griffiths, Prentice-Hall Inc., 3rd edition, 1999.
3. Introduction to Plasma Physics (Vol.-I) by Francis F. Chen, Plenum Press New York, 1984.
4. Introduction to Plasma Theory by D. R. Nicholson,John Wiley & Sons, New York 1983.
5. Introduction to Electrodynamics by A. Z. Capri and P. V. Panat, Alpha Science International Ltd; 2002.

SUGGESTED WEB SOURCES:

1. https://nptel.ac.in/courses/103/106/103106162/
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

CO-PO matrix for the course MPH204 (Electrodynamics)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4	PSO5
MPH204.1	3	2	2	3	2	3	3	3	3	2	3	3	2	1	2	2
MPH204.2	3	2	2	3	2	3	3	3	3	2	3	3	2	1	3	3
MPH204.3	3	2	2	3	2	3	3	3	3	2	2	3	2	1	2	2
MPH204.4	3	2	2	3	2	3	3	3	3	2	3	3	2	1	2	3
MPH204.5	3	2	2	3	2	3	3	3	3	2	3	3	2	1	2	3
MPH204.6	3	2	2	3	2	3	3	3	3	2	3	3	2	1	2	3
Average	3	2	2	3	2	3	3	3	3	2	3	3	2	1	2	3

M.Sc. PHYSICS SEMESTER-II

MPH205

SUBJECT NAME: PHYSICS LAB II

L	P		
		SESSIONAL:	30
L	P	END SEM EXAM:	70
0	16	TOTAL:	100

Course Outcomes (COs)

After successful completion of creative work about 'Lab Experiments' student will be able to learn

MPH105.1 *Utilize scientific methods for formal investigation of physical laws.*

MPH105.2 *Understand the fundamentals of various physical phenomena and physical concepts.*

MPH105.3 *Know and learn about various type of detectors used in nuclear physics experiments.*

MPH105.4 *Understand the phenomenon used in GM counter for estimating the range of different radioactive sources.*

MPH105.5 *Demonstrate competency with experimental methods that are used to discover and verify the concepts related to content and research* *knowledge.*

MPH105.6 *Analyze the structure of a crystalline solid in terms of lattice, basis, unit cell, reciprocal lattice, brillouin zone and symmetry elements*

MPH105.7 *Deduce the structure of a crystalline solid from an analysis of the XRD pattern and the theoretically calculated crystal structure factor.*

MPH105.8 *Learn about generation of energy by solar PV module.*

Students will perform at least 8 experiments of each of the following sections:

SECTION A:

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 temperatures and determination of bandgap.
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.
7. To calculate the corresponding Verdet's constant in each case and to evaluate Verdet's constant as a function of the wavelength.
8. Determination of dislocation energy of Iodine molecule by photography the absorption bands of I_2 in the visible region.
9. Determination of the wavelengths of the most intense spectral lines of He and Hg (two-electron Systems).
10. Determination of e/m of electron by normal Zeeman Effect using Febry Perot Etalon.
11. 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.
12. To understand how electric and magnetic fields impact an electron beam and experimentally determine the electron charge-to-mass ratio.
13. 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.

SECTION B:

1. To study the dispersion of lattice vibrations using an electrical analog of the real lattice.
2. To determine Lattice parameter and Miller Indices using XRD.
3. To find out the Magnetic susceptibility of hydrated copper sulfate.
4. To determine the Transition temperature of ferrites.
5. To study the phenomenon of magneto-resistance.
6. To study and perform Electron paramagnetic resonance(EPR) experiment.
7. To study glow curves by performing Thermo-luminescence studies.
8. To study the properties of High temperature superconductor.
9. To determine the Dielectric constant of benzene and dipole moment of acetone.
10. To study Solar cell characteristics.
11. To estimate the effect of sun tracking on energy generation by solar PV module.

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

SUGGESTED WEB SOURCES:

1. https://nptel.ac.in/courses/103/106/103106162/
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

CO-PO matrix for the course MPH205 (Physics Lab II)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4	PSO5
MPH205.1	3	2	3	3	3	3	3	2	3	3	2	3	3	2	3	3
MPH205.2	3	2	3	3	3	3	3	3	3	3	2	3	3	3	3	3
MPH205.3	3	3	3	2	2	2	2	2	3	3	2	3	3	3	3	3
MPH205.4	3	2	3	3	3	3	3	3	3	3	2	3	3	3	3	3
MPH205.5	3	2	3	3	3	3	3	3	3	3	3	3	3	3	2	2

MPH205.6	3	3	3	2	2	2	3	2	3	3	2	3	3	3	2	2
MPH205.7	3	2	3	3	3	3	3	3	3	3	2	3	2	2	2	2
MPH205.8	3	3	3	2	2	3	2	3	3	3	2	3	2	2	3	2
Average	3	2.37	3	2.62	2.62	2.75	2.75	2.75	3	3	2.12	3	2.75	2.63	2.63	2.5

M.Sc. PHYSICS SEMESTER-III

MPH301

SUBJECT NAME: ATOMIC AND MOLECULAR PHYSICS

NO OF CREDITS: 4

SESSIONAL: 25

L	P
4	0

THEORY EXAM: 75

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 Outcomes (COs)

After successful completion of the course on Atomic and Molecular Physics, a student will be able to:

MPH 301.1 Understand the fundamental aspects of origination of atomic physics, analysis of spectral lines.

MPH 301.2 Capable of understanding the change in behavior of atoms in external applied electric and magnetic field on atomic spectral lines, their selection rule.

MPH 301.3 Construct and analyze the rotational, vibrational spectra of molecules.
MPH 301.4 Understand the experimental and theoretical aspects of Raman spectra.

MPH 301.5 Understand electronic energy spectroscopy, its rule, spectral range, analysis of the electronic transitions in molecules.

MPH 301.6 Grasp about the knowledge of the nucleus interaction with external fields and effect on their spectrum to understand the molecule.

UNIT-1: Basics of Atomic Spectra (12 hrs)
Magnetic Dipole moments, Electron spin and vector model, Fine structure of hydrogen and hydrogen-like atoms-mass correction, Spin-orbit term, Darwin term, Intensity of fine structure lines, the 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.

UNIT-II Atomic Spectra (12 hrs)
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. X-ray spectra, X-ray emission, and Absorption spectra Auger effect, Spectra of Alkali elements

UNIT-III: Molecular Structure (12 hrs)
Born-Oppenheimer separation for diatomic molecules, rotation, vibration and electronic structure of diatomic molecules. Description of Molecular Orbital and Electronic Configuration of Diatomic Molecules: H2, H2+. Co-relation diagram for hetero-nuclear molecules.

UNIT-IV: Molecular Spectra (12 hrs)
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 predissociation, Dissociation energy, Rotational fine structure of electronic bands.

REFERENCE BOOKS:
1 Concept 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

SUGGESTED WEB SOURCES:

1. https://nptel.ac.in/courses/103/106/103106162/
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

CO-POs matrix for the course MPH 301 (Atomic and Molecular Physics)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4	PSO5
MPH301.1	3	3	3	3	3	3	2	3	2	2	2	2	2	2	2	2
MPH301.2	3	3	3	3	3	3	2	3	2	3	3	2	2	1	3	2
MPH301.3	3	3	3	3	3	3	2	3	2	3	2	2	3	2	3	3
MPH301.4	3	3	3	2	3	3	3	3	2	2	1	2	3	1	2	2
MPH301.5	3	2	3	3	3	2	3	2	1	2	2	3	2	1	2	3
MPH301.6	3	3	3	3	3	2	3	3	2	2	1	2	3	2	2	2
Average	3	2.83	3	2.83	3	2.66	2.5	2.83	1.83	2.5	1.83	2.16	2.5	1.5	2.33	2.33

M.Sc. PHYSICS SEMESTER-III

SUBJECT NAME: STATISTICAL MECHANICS
MPH302
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 Outcomes (COs)

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

MPH302.1 Realize the fundamental connection between statistical mechanics and thermodynamics.

MPH302.2 Learn the ensemble formulation of statistical mechanics, and apply these to calculate important thermodynamical quantities for simple systems.
MPH302.3 Formulate the quantum mechanical ensemble theory and use it to derive the laws of quantum statistics, viz. Fermi-Dirac (FD) and Bose-Einstein (BE) statistics.

MPH302.4 Apply the laws of quantum statistics to determine the equation of state for ideal Bose and Fermi gases, and understand the origin of Bose-Einstein condensation.

MPH302.5 Grasp the basics of cluster expansion method for a classical real gas to obtain its equation of state and simple cluster integrals.

MPH302.6 Construct and solve the Ising model, along with the Landau theory of phase transition and understand fluctuations.

PHY302.7 Understand fluctuations, their spectral analysis and connection with spatial correlations.

PHY302.8 Describe the theoretical basis of Brownian motion on the basis of Enistein-Smoluchowski, and Langevin approaches.

Unit I: Classical Statistical Mechanics (12 hrs.)
Foundations of Statistical Mechanics: The macroscopic and microscopic states, Postulate of equal a priori probability, Contact between statistics and thermodynamics; Ensemble theory: Concept of ensemble, Phase space, Density function, Ensemble average, Liouville's theorem, Stationary ensemble; The microcanonical ensemble, Application to the classical ideal gas; The canonical and grand canonical ensembles, Canonical and grand canonical partition functions, Calculation of statistical quantities; Thermodynamics of a system of non-interacting classical harmonic oscillators using canonical ensemble, and of classical ideal gas using grand canonical ensemble, Energy and density fluctuations; Entropy of mixing and the Gibbs paradox, Sackur-Tetrode equation.

Unit II: Quantum Statistical Mechanics (12 hrs.)

Quantum-mechanical ensemble theory: Density matrix, Equation of motion for density matrix, Quantum-mechanical ensemble average; Statistics of indistinguishable particles, Two types of quantum statistics- Fermi-Dirac and Bose-Einstein statistics, Fermi-Dirac and Bose-Einstein distribution functions using microcanonical and grand canonical ensembles (ideal gas only), Statistics of occupation numbers; Ideal Bose gas: Internal energy, Equation of state, Bose-Einstein Condensation and its critical conditions; Bose-Einstein condensation in ultra-cold atomic gases: its detection and thermodynamic properties; Ideal Fermi gas: Internal energy, Equation of state, Completely degenerate Fermi gas.

Unit III: Non-Ideal Systems (12 hrs.)

Cluster expansion method for a classical gas, Simple cluster integrals, Mayer-Ursell relations, Virial expansion of the equation of state, Van der Waal's equation, Validity of cluster expansion method; Phase transitions: Construction of Ising model, Solution of Ising model in the Bragg-William approximation, Exact solution of the one-dimensional Ising model; Critical exponents, Landau theory of phase transition, Scaling hypothesis.

Unit IV: Fluctuations (12 hrs.)

Thermodynamic fluctuations and their probability distribution law, Spatial correlations in a fluid, Connection between density fluctuations and spatial correlations; Brownian motion, the Langevin theory of the Brownian motion (derivations of mean square displacement and mean square velocity of Brownian particle), Auto-correlation function and its properties, The fluctuation-dissipation theorem, Diffusion coefficient; the Fokker-Planck equation; Spectral analysis of fluctuations: the Wiener-Khintchine theorem.

REFERENCE BOOKS

1. Statistical Mechanics by R. K. Pathria and P. D. Beale (2011), United States: Elsevier/Academic Press. (3rd edition)
2. Statistical and Thermal Physics by F. Reif (2010) Waveland Press.
3. Statistical Mechanics by K. Huang (1963). New York: Wiley.
4. Statistical Mechanics by L. D. Landau and I. M. Lifshitz (1980), USSR Academy of Sciences.
5. Statistical Mechanics by R. Kubo (1965) Amsterdam: North-Holland.

SUGGESTED WEB SOURCES:

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MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

CO-PO matrix for the course MPH302 (Statistical Mechanics)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4	PSO5
MPH302.1	3	3	3	3	3	3	2	3	3	2	3	3	3	2	3	3
MPH302.2	3	3	3	3	2	3	2	3	3	2	3	3	3	3	3	3
MPH302.3	3	3	3	3	2	3	2	2	3	2	2	3	3	3	3	3
MPH302.4	3	3	3	3	2	3	2	2	3	2	2	3	3	3	3	3
MPH302.5	3	3	2	3	2	3	2	2	3	2	3	3	3	3	2	2
MPH302.6	3	3	2	3	2	3	2	2	3	2	2	3	3	3	2	2
MPH302.7	3	3	2	3	2	3	2	2	3	2	2	3	2	2	2	2
MPH302.8	3	3	2	3	1	3	2	2	3	2	1	3	2	2	3	2
Average	3	3	2.5	3	2	3	2	2.25	3	2	2.25	3	2.75	2.63	2.63	2.5

M.Sc. PHYSICS SEMESTER-IV

MPH401

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 2 marks each. It should cover the entire syllabus. Part II will consist of six questions of 10 marks each out of which the student has to attempt any four.

COURSE OUTCOMES (COs)

After successful completion of course on Laser Technology, students will be able to:

MPH401.1 Understand the basic principles of a laser system and conventional sources.

MPH401.2 Learn *about the basic properties and characteristics of laser light.*

MPH401.3 Learn principle and working of various lasers including gas, liquid and solid-state.

MPH401.4 Know principle and working of semiconductor lasers and its type, p-n junction laser.
MPH401.5 Understand the nonlinear optics and brief about harmonic generation.

MPH401.6 Generate phase matching conditions and self-focusing in nonlinear optics.
MPH401.7 Learn about Raman scattering and types of Raman Scattering in nonlinear optics
MPH401.8 *Describe certain applications like laser c*ooling and trapping of atoms along with Bose Condensation.

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.

REFERENCE BOOKS:

1. Laser Spectroscopy and Instrumentation, Demtroder, Springer
2. Principles of Lasers, Svelto, Orazio, Fifth edition, Springer
3. Atom, Laser and Spectroscopy, 2nd Edition, Kindle Edition, S. N. Thakur, D. K. Rai,PHI Publication
4. Laud: Laser and nonlinear optics, B.B. Laud, New Age International Pvt Ltd Publishers.
5. Lasers:Fundamentals and Applications, Thyagarajan, K., Ghatak, Ajoy, Springer

SUGGESTED WEB SOURCES:

1. https://nptel.ac.in/courses/103/106/103106162/
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

CO-PO matrix for the course MPH401 (Laser Technology)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4	PSO5
MPH401.1	3	3	3	3	3	3	2	3	3	2	3	3	3	2	3	3
MPH401.2	3	3	3	3	2	3	2	3	3	2	3	3	3	3	3	3
MPH401.3	3	3	3	3	2	3	2	2	3	2	2	3	3	3	3	3
MPH401.4	3	3	3	3	2	3	2	2	3	2	2	3	3	3	3	3
MPH401.5	3	3	2	3	2	3	2	2	3	2	3	3	3	3	2	2
MPH401.6	3	3	2	3	2	3	2	2	3	2	2	3	3	3	2	2
MPH401.7	3	3	2	3	2	3	2	2	3	2	2	3	2	2	2	2
MPH401.8	3	3	2	3	1	3	2	2	3	2	1	3	2	2	3	2
Average	3	3	2.5	3	2	3	2	2.25	3	2	2.25	3	2.75	2.63	2.63	2.5

M.Sc. PHYSICS SEMESTER-IV

MPH402
SUBJECT NAME: MATERIAL SCIENCE

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 2 marks each. It should cover the entire syllabus. Part II will consist of six questions of 10 marks each out of which the student has to attempt any four.

Course Outcomes (COs)

After successful completion of the course on Material Science-I, a student will be able to:

MPM303.1 *Understand the basic concepts and properties of Materials.*

MPM303.2 *Describe how and why defects (point, line and planar) in materials greatly affect engineering properties and limit their use in service*

MPM303.3 *Understand strengthening and grasp the importance of various strengthening mechanisms.*

MPM303.4 *Describe various parameters involved in elastic deformation, plastic deformation, inelastic deformation etc.*

MPM303.5 *Grasp the concept of magnetization in materials.*

MPM303.6 *Comprehend magnetic, dielectric, optical and ferroelectric materials.*

MPM303.7 *Elucidate the polarizability in materials and analysis of dielectric materials for various applications.*

MPM303.8 *Develop structure-property correlation for design of materials.*

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 dimensions, 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: Magnetic Materials (12 hrs.)

Magnetic Processes: Larmor frequency; Diamagnetism, magnetic susceptibility, Langevin's diamagnetism equation; Paramagnetism, Curie constant, the density of states curves for a metal; Ferromagnetism, Curie temperature, Curie-Weiss law, exchange interactions, domain structure; Antiferromagnetism and magnetic susceptibility of an antiferromagnetic material; Ferrimagnetism and Ferrites; Paramagnetic, ferromagnetic and cyclotron-resonance.

Unit IV: Dielectrics, Optical, and Ferroelectric Materials (12 hrs.)

Polarization, Macroscopic electric field, Dielectric susceptibility, Local electric field at an atom, Dielectric constant and polarizability, Clausius-Mossotti relation, Electronic polarizability, Classical theory of electronic polarizability; Structural phase transitions; Ferroelectric crystals and their classification; Landau theory of the phase transition; Optical absorption, transmission and reflection.

REFERENCES:

1. J.C. Anderson, K.D. Leaver, P. Leevers and R.D. Rawlings, Materials Science for Engineers, CRC Press, London.
2. V. Raghavan, Materials Science and Engineering: A First Course, PHI Learning, New Delhi.
3. C. Kittel, Introduction to Solid State Physics, Wiley, India.
4. A.J. Dekker, Solid State Physics, Macmillan Press, London.
5. W.D. Callister, Materials Science and Engineering : An Introduction, John Wiley, New York.
6. G.E. Dieter, Mechanical Metallurgy, McGraw Hill, New York.
7. Milton Ohring, Engineering Materials Science, Academic Press, USA.

SUGGESTED WEB SOURCES:

1. https://nptel.ac.in/courses/103/106/103106162/
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14

3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

CO-PO matrix for the course MPH402 (Materials Science)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4	PSO5
MPH402.1	3	2	-	1	-	1	1	-	-	-	1	3	3	2	3	3
MPH402.2	3	2	1	2	1	2	1	1	1	-	1	3	3	3	3	3
MPH402.3	3	2	-	1	-	1	1	-	-	-	1	3	3	3	3	3
MPH402.4	3	2	-	2	-	2	1	-	1	-	1	3	3	3	3	3
MPH402.5	3	2	-	1	-	1	1	-	-	-	1	3	3	3	2	2
MPH402.6	3	3	1	3	1	3	1	1	2	-	2	3	3	3	2	2
MPH402.7	2	3	1	3	1	3	1	1	2	-	2	3	2	2	2	2
MPH402.8	1	3	-	3	2	3	1	2	2	-	3	3	2	2	3	2
Average	2.625	2.375	1	2	1.25	2	1	1.25	1.6	-	1.5	3	2.75	2.63	2.63	2.5

SPECIALIZATION-I: NUCLEAR PHYSICS

M.Sc. PHYSICS SEMESTER-III

MPN303

SUBJECT NAME: NUCLEAR REACTIONS

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 A will consist of 10 short answer type questions of 1.5 marks each. It should cover the entire syllabus. Part B will consist of five questions of 15 each out of which the student has to attempt any four.

Course Outcomes (COs)

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

MPH303.1 *Differentiate between different types of nuclear reactions, relevant aspects associated with nuclear reactions and kinematics of such reactions.*

MPH303.2 *Acquire conceptual understanding of nuclear cross section*

MPH303.3 *Know and learn about the theory of Deuteron and explore it's applications*

MPH303.4 *Understand the neutron-proton scattering and concept of scattering length*

MPH303.5 *Understand the quantum formulation of nuclear reaction*

MPH303.6 *Know concept of cross section and apply it to resonances in quantitative way*

MPH303.7 *Learn nuclear fission and its related theories*

MPH303.8 *Understand nuclear fusion its reaction rates and cross section*

Unit - I: Basics of Nuclear Reactions (12 hrs)

Type of nuclear reactions, Q-value of nuclear reactions and its determination. Collision between subatomic particles, elastic collision in L-system, elastic collision in C-system (Non-relativistic), Invariance in nuclear reactions. Basic concepts of cross section: Total cross section, Partial cross section, differential cross section. Cross section in terms of partial wave analysis.

Unit - II: Two Body Problem (Deuteron - $^1H_2$)(12 hrs)
Physical properties of Deuteron: Mass, binding energy, spin or total angular momentum, parity, magnetic moment and electric quadrupole moment. Ground state of Deuteron (square well potential), Range depth relationship for square well potential. Concept of scattering length and significance of its sign. Spin dependence of neutron- proton scattering, Effective range theory of neutron-proton scattering.

Unit – III: Quantum Formulation of Nuclear Reaction (12 hrs)

Breit-Wigner dispersion formula for s-wave neutrons of low energy, compound nucleus, Form of the optical potential: Square well, Woods-Saxon and spin dependent optical potential. Elastic scattering and reaction cross section with optical model. Kapur-Peierls dispersion formula for potential scattering, Limitations of the optical model. Stripping and pick-up reactions.

Unit – IV: Fission & Fusion reactions (12 hrs)

Nuclear Fission: Types of fission, energy released in fission, nature of fission fragments, neutron emission in fission process, Bohr & Wheeler theory of nuclear fission and it's limitations, four factor formula, conditions for controlled chain reactions, Nuclear Fusion: Basic introduction of Plasma, fusion reactions, energy balance & Lawson criterion, cross section of fusion, reaction rates.

REFERENCE BOOKS:

1. Nuclear Physics: Principle and Application by John Lilley (Wiley Pub.).
2. Concepts of Nuclear Physics by Bernard L. Cohen (TMH).
3. Nuclear Physics: Theory and Experiment by R. R. Roy and B. P. Nigam (New Age Int.)
4. Nuclear Physics Experimental and Theoretical by H. S. Hans (New Age Int.).
5. Introduction to nuclear reactions G R Satchler (Oxford university Press)
6. Introductory Nuclear Physics. By Kenneth S. Krane. (John Wiley & Sons, 1987)
7. Nuclear & Particle physics, by S. L. Kakani & S. Kakani (Viva Books)
8. Nuclear Physics by S. N. Ghoshal (S. Chand Pub.)

SUGGESTED WEB SOURCES:

1. https://nptel.ac.in/courses/103/106/103106162/

2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

CO-PO matrix for the course MPN303 (Nuclear Reactions)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4	PSO5
MPN303.1	3	2	-	1	-	1	1	-	-	-	1	3	2	-	3	1
MPN303.2	3	2	1	2	1	2	1	1	1	-	1	3	3	-	3	1
MPN303.3	3	2	-	1	-	1	1	-	-	-	1	3	3	-	2	1
MPN303.4	3	2	-	2	-	2	1	-	1	-	1	3	3	-	3	1
MPN303.5	3	2	-	1	-	1	1	-	-	-	1	3	2	-	3	1
MPN303.6	3	3	1	3	1	3	1	1	2	-	2	3	3	-	3	1
MPN303.7	2	3	1	3	1	3	1	1	2	-	2	3	3	-	3	1
MPN303.8	1	3	-	3	2	3	1	2	2	-	3	3	3	-	3	1
Average	2.625	2.375	1	2	1.25	2	1	1.25	1.6	-	1.5	3	2.75	-	2.875	1

M.Sc. PHYSICS SEMESTER-III

MPN304

SUBJECT NAME: NUCLEAR DETECTORS

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 A will consist of 10 short answer type questions of 1.5 marks each. It should cover the entire syllabus. Part B will consist of five questions of 15 each out of which the student has to attempt any four.

Course Outcomes (COs)

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

MPH304.1	*Learn about the theoretical aspects of design and usage of various nuclear detectors and their applications in the field of nuclear physics.*
MPH304.2	*Learn about the concept, working, types and properties of various gas filled detectors.*
MPH304.3	*Understand various operation regions in different gas filled detectors.*
MPH304.4	*Know the Solid state detectors (Basics, construction, working, advantages, disadvantages)*
MPH304.5	*Understand the types and characteristics of Solid State detectors*
MPH304.6	*Understand the classification, mechanisms, and properties of scintillator detectors.*
MPH304.7	*Describe the factors affecting performance of scintillator detectors*
MPH304.8	*Learn about the other miscellaneous detector types*

Unit-I: Gas Detectors (12 hrs)

Ionization Chamber (Ionization in gas, Charge migration and collection, Design and operation of DC Ion chambers, Exposure and dose measurements, Pulse mode operation), Proportional counter (Gas multiplication, design of proportional counter, Counting curve and applications, Gas electron multiplier), Geiger-Muller Counters (The Geiger discharge, Geiger plateau, Counting efficiency).

Unit-II: Solid State Detectors (12 hrs)

Basics of semiconductors, Solid state detectors (Basics, construction, working, advantages, disadvantages), Types of semiconductor detectors (Diffused junction, surface barrier, Lithium-Drifted Silicon Si(Li), Lithium-Drifted Germanium detectors, Ge(Li), High purity Germanium detectors), Characteristics of semiconductor detectors (Average energy, Linearity, leakage current, Intrinsic efficiency and sensitivity), Compound semiconductor detectors.

Unit-III: Scintillation Detectors (12 hrs)

Principle, Properties and types of scintillator detectors, Factors affecting performance of scintillator detectors, Inorganic scintillators (Mechanism and characteristics of Thallium activated sodium iodide-NaI(Tl) scintillator), Organic scintillators (Mechanism, Types and Response of Organic scintillators), Basics of Fiber scintillators and Noble gas scintillators, Photo and electron multipliers: Photomultiplier tubes and Channel electron multipliers.

Unit-IV: Miscellaneous Detector Types (12 hrs)

Statistics of counting: Normal, Poisson and Gaussian distribution, Solid state nuclear track detectors (Visualization of the tracks of ionizing radiations, mechanism of formations of tracks, etching and advantages), Construction, operation, applications, merit and demerits of the Spark Chamber , The Bubble chamber, Cloud chamber, Chernokov detectors.

REFERENCE BOOKS:

1. Radiation Detection and Measurement by G. F. Knoll (John Wiley & Sons, Inc. 3rd Ed., 2000)
2. Nuclear Radiation Detectors by S. S. Kapoor and V. S. Ramamurthy (New Age Int.).
3. Techniques for Nuclear and Particle Physics Experiments by W. R. Leo (Springer-Verlag)
4. Nuclear Radiation Detection, Measurements and Analysis by K. Muraleedhara Varier (Narosa)

SUGGESTED WEB SOURCES:

1. https://nptel.ac.in/courses/103/106/103106162/
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

CO-PO matrix for the course MPN304 (Nuclear Detectors)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4	PSO5
MPN304.1	3	2	-	1	-	1	1	-	-	-	1	3	2	-	1	3
MPN304.2	3	3	1	3	1	3	1	1	2	-	2	3	3	1	3	3
MPN304.3	3	2	-	2	-	2	-	-	2	-	2	3	3	-	2	3
MPN304.4	3	2	-	1	-	2	-	-	1	-	1	3	3	1	3	3
MPN304.5	3	3	-	3	1	3	1	2	2	1	2	3	2	-	2	3
MPN304.6	1	3	-	3	1	3	1	3	3	1	3	3	3	1	3	3
MPN304.7	3	3	-	2	1	2	1	2	2	1	2	3	3	-	3	3
MPN304.8	1	3	-	3	1	3	1	3	3	1	3	3	3	1	3	3
Average	2.5	2.625	1	2.25	1	2.375	1	2.2	2.143	1	2	3	2.75	0.5	2.5	3

M.Sc. PHYSICS SEMESTER-III

MPN305

SUBJECT NAME: NUCLEAR PHYSICS SPECIALIZATION LAB

NO OF CREDITS: 8

L	P		
		SESSIONAL:	30
		END SEM EXAM :	70
0	16	TOTAL:	100

Course Outcomes (COs)

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

MPN305.1 *Understand the working of GM Counter and measure the end point energy and resolving time of source of given sample.*

MPN305.2 *Learn to verify inverse square law and find the Linear & mass attenuation coefficient using gamma source*

MPN305.3 *Understand the various scattering processes*

MPN305.4 *Able to determine the operating voltage of a photomultiplier tube*

MPN305.5 *Acquire practical knowledge on calibrating a gamma ray spectrometer and to determine the energy of a given gamma ray source.*

MPN305.6 *Analyze half life of radioactive nuclei*

MPN305.7 *Learn to determine the beta ray spectrum of a beta source (like Cs-137) and to calculate the binding energy of the K-shell electron of a given source.*

MPN305.8 *Understand few experiments using computation codes & Simulations*

Experiments for specializations in Nuclear Physics

Section A

1. To study the characteristics of G.M. Counter.
2. To find the end point energy of a given source using G.M. Counter.
3. To find the absorption coefficient of given material using G.M. counter.
4. To study the Solid State Nuclear Track Detector.
5. To determine the mass absorption coefficient for beta rays.
6. To study Nuclear counting statistics.
7. To measure the short half-life of a radioactive nuclei.
8. To verify the inverse square law using gamma rays.

9. To estimate the efficiency of GM detector for (a) gamma source (b) beta source
10. To find the Linear & mass attenuation coefficient using gamma source.
11. To study the counting statistics for radioactive decay using SSNTD.
12. To determine the operating voltage of a photomultiplier tube.
13. To find the efficiency of a NaI (Tl) detector.
14. To determine the range and energy of alpha particles using spark counter
15. To study the Compton Scattering experiment.
16. To study the Rutherford backscattering experiment.
17. To study Poisson and Gaussian distributions using a GM Counter.
18. To calibrate a gamma ray spectrometer and to determine the energy of a given gamma ray source.
19. To determine the beta ray spectrum of a beta source (like Cs-137) and to calculate the binding energy of the K-shell electron of a given source.
20. To study the various modes in a multichannel analyzer and to calculate the energy resolution, energy of gamma ray.

Section B

Experiments using computation codes & Simulations

1. To study Compton scattering using computer code
2. To study the Rutherford scattering through code
3. To study energy losses by light and heavy ions passing through matter using code
4. To find the radial part of wave function of deuteron in its ground state using Runge- Kutta Method
5. To solve the s-wave Schrodinger equation for the ground state of the hydrogen atom.
6. Simulation of nuclear radioactivity by Monte Carlo technique.

SUGGESTED WEB SOURCES:

1. https://nptel.ac.in/courses/103/106/103106162/
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

CO-PO matrix for the course MPN305 (Nuclear Physics Specialization Lab)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4	PSO5

MPN305.1	3	2	-	1	-	1	1	-	-	-	1	3	2	3	2	3
MPN305.2	3	3	1	3	1	3	1	1	2	-	2	3	3	3	3	3
MPN305.3	3	2	-	2	-	2	-	-	2	-	2	3	3	3	2	3
MPN305.4	3	2	-	1	-	2	-	-	1	-	1	3	3	3	3	3
MPN305.5	3	3	-	3	1	3	1	2	2	1	2	3	2	3	2	3
MPN305.6	1	3	-	3	1	3	1	3	3	1	3	3	3	3	3	3
MPN305.7	3	3	-	2	1	2	1	2	2	1	2	3	3	3	3	3
MPN305.8	1	3	-	3	1	3	1	3	3	1	3	3	3	3	3	3
Average	2.5	2.625	1	2.25	1	2.375	1	2.2	2.143	1	2	3	2.75	3	2.625	3

M.Sc. PHYSICS SEMESTER-IV

MPN403

SUBJECT NAME: NUCLEAR MODELS AND ASTROPHYSICS

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 A will consist of 10 short answer type questions of 1.5 marks each. It should cover the entire syllabus. Part B will consist of five questions of 15 marks each out of which the student has to attempt any four.

Course Outcomes (COs)

After successful completion of the course on Nuclear Models and Astrophysics, a student will be able to:

MPN403.1 *Learn basics of nuclear liquid drop model, nuclear fission process and nuclear shell model.*

MPN403.2 *Predict ground state properties like spin, parity, magnetic dipole moment, electric quadrupole moment of nuclei by employing nuclear shell model.*

MPN403.3 *Understand types of multipole deformations and surface vibrations in heavy nuclei.*

MPN403.4 *Apply nuclear collective model in predicting low lying rotational and vibrational excited states of nuclei.*

MPN403.5 *Acquire conceptual understanding of the general theory of nuclear scattering and reactions.*

MPN403.6 *Analyze the cross sections for compound and direct nuclear reactions.*

MPN403.7 *Understand the key features of nuclear reactions involving weakly bound nuclei and heavy induced ion reactions.*

MPN403.8 *Appreciate the importance of recent research activities being carried out by using beams of rare isotopes.*

Unit-I : Nuclear Models (12 hrs)

Fermi gas model, Liquid Drop Model, merits and limitations of liquid drop model. Evidence for nuclear shell structure, Concept of magic numbers, Three-dimensional central Schrodinger equation, square-well potential: the energy eigenvalue problem for bound states, The harmonic oscillator potential, Nuclear spin orbit interaction, Qualitative idea about the Nilsson model, superfluid model

Unit-II: Application of Nuclear Models (12 hrs)

Applications of extreme single particle shell model and its predictions regarding ground state spin parity, magnetic moment and electric quadrupole moments, Schmidt lines, Collective model, Rotational mode, Rotational energy spectra and the nuclear wave function for even-even and odd-A nuclei, Vibrational mode, Potential energy and total Hamiltonian in vibration mode.

Unit-III: Exotic Nuclei (12 hrs)

Nuclear landscape and drip lines, qualitative idea of production of exotic nuclei, structure and properties of exotic nuclei and their application in astrophysics, evidence of breakdown of magic numbers, Halo & Skin structure, GDR and soft dipole resonance (reaction point of view)

Unit-IV: Nuclear Astrophysics (12 hrs)

Evolution of stars, Nuclear synthesis of elements in stars, hydrogen chain, carbon chain, energy liberation rate, Neon cycle, emission of neutrino from the core of stars, Chandrasekhar limit and white dwarfs, introduction of neutron star, basic introduction of r-process, supernova, cosmic rays, types and properties of primary cosmic rays, qualitatively idea of interaction of primary cosmic rays with atom.

REFERENCE BOOKS:

1. Theory of Nuclear Structure by M. K. Pal (Scientific and Academic Editions(1983)
2. Nuclear Physics: Theory and Experiment by R. R. Roy and B. P. Nigam (New Age Int.)
3. Nuclear Physics Experimental and Theoretical by H. S. Hans (New Age Int.).
4. Basic ideas and concepts in Nuclear Physics by K. Heyde (Second Edition Overseas Press)
5. Nuclear Structure Vol. 1& 2 by A. Bohr and Ben R. Mottelson (world Scientific)
6. Nuclear shell theory by Amos de- Shalit and I. Talmi (New York Academic press)
7. Fundamental of Nuclear Physics by Jahan Singh (Pragati Publication)
8. Nuclear Physics by S. N. Ghoshal (S Chand)
9. Halo Nuclei by Jim Al Khalili (A Morgan & Claypool Publication)
10. Physics of radioactive beam by C. A. Bertulani, M.S. Hussian, G. Munzenberg(Nova Science Publishers)
11. Nuclear Astrophysics by Md A. Khan (CRC Press, Taylor & Francis Group)

SUGGESTED WEB SOURCES:

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2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14

3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

CO-PO matrix for the course MPN403 (Nuclear Models and Astro Physics)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4	PSO5
MPN403.1	3	3	3	3	3	3	3	3	2	2	2	3	3	2	3	3
MPN403.2	3	3	3	3	3	3	3	3	2	2	2	3	3	2	3	3
MPN403.3	3	3	3	3	3	2	3	2	2	2	2	3	3	2	3	3
MPN403.4	3	3	3	3	3	2	2	2	2	2	2	3	3	2	3	3
MPN403.5	3	3	3	3	3	2	2	2	2	2	2	3	3	2	3	3
MPN403.6	3	3	3	3	3	2	2	2	2	2	2	3	3	2	3	3
MPN403.7	3	3	3	3	3	2	2	2	2	2	2	3	3	2	3	3
MPN403.8	3	3	3	3	3	1	2	2	2	2	2	3	3	2	3	3
Average	3	3	3	3	3	2.12	2.37	2.25	2	2	2	3	3	2	3	3

M.Sc. PHYSICS SEMESTER-IV

MPN404

SUBJECT NAME: NUCLEAR TECHNIQUES AND NEUTRON 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 A will consist of 10 short answer type questions of 1.5 marks each. It should cover the entire syllabus. Part B will *consist of five questions of 15 marks each out of which the student has to attempt any four.*

Course Outcomes (COs)

After successful completion of the course on Nuclear Techniques and Neutron Physics, a student will be able to:

MPN404.1	*Understand the resonance and non-resonance method.*
MPN404.2	*Understand the concept of high energy accelerators.*
MPN404.3	*Realize the relativistic kinematics and its importance in calculations at relativistic energies.*
MPN404.4	*Construct Analysis of the decay energy in various high energy reactions.*
MPN404.5	*Understand the interaction of charged particles with matter and will be able to calculate the dynamics of high energy particles.*
MPN404.6	*Learn the basics of Neutron Physics, their classification and their methods of production*
MPN404.7	*Understand radiation mechanism at relativistic velocities.*
MPN404.8	*Grasp details of particle accelerators for the creation of high energy particles*

Unit-I: Determination of Nuclear Properties (12 hrs)

Mass measurement using ion optics, Dempster's semicircular focusing, Aston's, Bainbridge, atomic beam method of nuclear magnetic moment determination, non-resonance & resonance method, electron paramagnetic resonance, nuclear induction method, determination of electric quadrupole moment.

Unit-II: Radiofrequency Accelerators (12 hrs)

Basic principles and components of accelerators, Linear accelerators - Resonance acceleration and phase stability, electron and proton Linacs. Circular accelerators-

Cyclotron, Frequency Modulated Synchrocyclotron, AVF Cyclotron, Alternating-gradient accelerators.

Unit-III: Electrostatic and Heavy Ion Accelerators (12hrs)

Van de Graaff voltage generator, Cockcroft-Walton voltage generator, insulating column, voltage measurement, Acceleration of heavy ions, Tandem electrostatic accelerator, Production of heavy negative ions, Pelletron and Tandetron. Qualitative idea about Storage ring accelerators and large hadron collider (LHC).

Unit-IV: Neutron Physics (12 hrs)

Basic properties of neutron, classification of neutrons, methods for neutron production: Radioactive sources as (**α,n**) reactions, photo neutron sources, interaction of neutrons with nuclei and with matter in bulk, general properties of neutron detection, Different types of nuclear fission reactors, Plasma, critical temp confinement of hot plasma, Magnetic confinement of plasma, plasma lose. Qualitative idea about fusion reactor (Tokamak).

REFERENCE BOOKS:

1. Techniques for Nuclear and Particle Physics Experiments by W R Leo (Springer-Verlag)
2. Nuclear Radiation Detection, Measurements and Analysis by K Muraleedhara Varier (Narosa)
3. Particle Accelerator Physics, Vol I and II, H.J. Wiedman, Springer Verlag (1998)
4. Particle Accelerators, M.S. Livingston and J.P. Blewel, McGraw-Hill Book Press.
5. Nuclear Spectroscopy and Reactions Part-A, Ed. J. Cerny, Academic Press, 1974.
6. Theory of Resonance Linear Accelerators by I.M. Kapchenkey, Harwood, Academic Publishers.
7. Nuclear physics: Principles and applications by John Lilley (Wiley-India)
8. Fundamental of Nuclear Physics by Jahan Singh (Pragati Publication)
9. Nuclear Physics by Dr. S N Ghoshal (S Chand)
10. Fundamental of Nuclear Physics by Jahan Singh (Pragati Publication)

SUGGESTED WEB SOURCES:

1. https://nptel.ac.in/courses/103/106/103106162/
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

CO-PO matrix for the course MPN404 (Nuclear Techniques and Neutron Physics)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4	PSO5
MPN404.1	3	3	3	3	3	3	3	3	2	2	2	3	3	2	3	3
MPN404.2	3	3	3	3	3	3	3	3	2	2	2	3	3	2	3	3
MPN404.3	3	3	3	3	3	2	3	2	2	2	2	3	3	2	3	3
MPN404.4	3	3	3	3	3	2	2	2	2	2	2	3	3	2	3	3
MPN404.5	3	3	3	3	3	2	2	2	2	2	2	3	3	2	3	3
MPN404.6	3	3	3	3	3	2	2	2	2	2	2	3	3	2	3	3
MPN404.7	3	3	3	3	3	2	2	2	2	2	2	3	3	2	3	3
MPN404.8	3	3	3	3	3	1	2	2	2	2	2	3	3	2	3	3
Average	3	3	3	3	3	2.12	2.37	2.25	2	2	2	3	3	2	3	3

SPECIALIZATION-II: MATERIALS SCIENCE
M.Sc. PHYSICS SEMESTER-III

MPM303
SUBJECT NAME: MATERIALS CHARACTERIZATION TECHNIQUES

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 2 marks each. It should cover the entire syllabus. Part II will consist of six questions of 10 marks each out of which the student has to attempt any four.

COURSE OUTCOMES (COs):

After successful completion of course on Material Characterization Techniques, students will be able to:

MPH303.1 Know brief about the techniques to characterize the materials.

MPH303.2 Explain classification of characterization techniques and determination of crystal structure of specimen

MPH303.3 Estimate crystallite size and stress of crystalline materials by using X-ray diffraction methods.

MPH303.4 Apply appropriate characterization techniques for microstructure examination at different magnification level and use them to understand the microstructure of various materials.

MPH303.5 Choose appropriate electron and atomic microscopy techniques to investigate microstructure of materials at high resolution.

MPH4303.6 Use appropriate optical technique to measure vibrational / electronic transitions to estimate parameters like energy band gap, elemental concentration, etc.

MPH303.7 Know thermal analysis techniques to determine thermal stability of and thermodynamic transitions of the specimen.

MPH303.8 Understand the magnetic material characterization and its analysis.

Unit-I: Structural Characterization and Analysis (12hrs):

Introduction to materials characterization, Bragg's Law, Generation and detection of X-rays, X-ray diffraction methods (XRD), Determination of crystal structure, Lattice Parameter, Crystallite Size, Lattice Strain measurements, Williamson Hall Plot; Electron diffraction.

Unit-II: Electron Microscopy and Surface Analysis (12hr):

Interaction of electrons with solids, Scanning electron microscopy(SEM), Transmission electron microscopy(TEM), Scanning transmission electron microscopy(STEM), Scanning Probe Microscope (SPM): Atomic force microscopy (AFM), scanning tunneling microscopy(STM).

Unit-III: Optical and Thermal Characterization (12hrs):

Optical Microscopy, UV/Visible spectroscopy, Fourier Transform Infrared spectroscopy(FTIR), Atomic absorption spectroscopy(AAS), Raman spectroscopy. Thermo gravimetric analysis(TGA), Differential thermal analysis(DTA), Differential Scanning Calorimetry (DSC),.

Unit-IV: Magnetic Characterization (12hrs):

Spectroscopy Techniques: Basic of nuclear magnetic resonance (NMR) and electron spin resonance (ESR) spectroscopy, Magnetic Measurements: Vibrating Sample Magnetometer (VSM), Superconducting Quantum Interference Device (SQUID), Magnetic Force Microscopy, Mössbauer Spectroscopy.

REFERENCE BOOKS:

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

SUGGESTED WEB SOURCES:

1. https://nptel.ac.in/courses/103/106/103106162/
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

CO-PO matrix for the course MPM303 (Materials Science)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4	PSO5

MPM303.1	3	2	-	1	-	1	1	-	-	-	1	3	2	-	1	3
MPM303.2	3	3	1	3	1	3	1	1	2	-	2	3	3	-	3	3
MPM303.3	3	2	-	2	-	2	-	-	2	-	2	3	3	-	2	3
MPM303.4	3	2	-	1	-	2	-	-	1	-	1	3	3	-	3	3
MPM303.5	3	3	-	3	1	3	1	2	2	1	2	3	2	-	2	3
MPM303.6	1	3	-	3	1	3	1	3	3	1	3	3	3	-	3	3
MPM303.7	3	3	-	2	1	2	1	2	2	1	2	3	3	-	3	3
MPM303.8	1	3	-	3	1	3	1	3	3	1	3	3	3	-	3	3
Average	2.5	2.625	1	2.25	1	2.375	1	2.2	2.143	1	2	3	2.75	-	2.5	3

M.Sc. PHYSICS SEMESTER-III

MPM304

SUBJECT NAME: FUNDAMENTALS AND SYNTHESIS OF NANOMATERIALS

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 2 marks each. It should cover the entire syllabus. Part II will consist of six questions of 10 marks each out of which the student has to attempt any four.

COURSE OUTCOMES (COs):

After successful completion of course on Fundamentals and Synthesis of Nanomaterials, students will be able to:

MPM304.1 Understand the basics of nanotechnology and its implications in modifying the properties of materials at the nanoscale.

MPM304.2 Learn with quantum phenomena used in nanostructured materials.

MPM304.3 Concept of Quantum confinement, 3D,2D,1D and 0D nanostructure with examples.

MPM304.4 Know about the role of carbon family in nanotechnology with its applications.

MPM304.5 Different synthesis techniques including top down and bottom up approaches and able to apply appropriate Non Lithographics for development of nanomaterials

MPM304.6 Develop nano devices using Lithographic techniques.

MPM304.7 Use Chemical synthesis techniques to growth of Nanomaterials.

MPM304.8 Understand the coating techniques to prepare the thin film.

Unit I: **Introduction and Quantum mechanical concepts at Nanoscale (12hrs)**:
Introduction to nanomaterials, Band Structure, Density of states of nanoscale Size, Applications of Schroedinger equation, confined particle in 1D, potential step: reflection and tunneling. penetration of barrier, potential box: trapped particle in 3D;Nanodot, electron trapped in 2D plane; Nano sheet, electron moving in 1D; Nanowire/rod/belt. Quantum confinement in nanomaterials, Surface to volume ratio.

Unit-II: Carbon based Nanomaterials (10hrs)
Introduction to Carbon Clusters, CNTs and synthesis of carbon nanotubes. Growth mechanism, electronic structure of carbon nanotubes, preparation and characterization of fullerenes and graphene. Nanodiamond, Defects and purifications in CNT(Brief).

Unit III: **Synthesis of Nanomaterials-I (14 hrs):**
Physical Methods: Top-down vs. Bottom-up Technique, Nonlithographic Techniques: Plasma Arc Discharge, Sputtering, Electron Beam and Thermal Evaporation , Pulsed Laser Deposition, Molecular Beam Epitaxy. Lithographic Process and its Limitations: Electron beam lithography, Ion beam lithography, Photo lithography, x-ray lithography.

Unit IV: **Synthesis of Nanomaterials-II (12 hrs):**
Chemical Methods: Chemical Vapor Deposition (CVD), Sol-gels techniques, Co-precipitation, Hydrothermal, Spin and Dip coating techniques and Spray pyrolysis, Chemical Etching Techniques, Electroplating, Langmuir Blodgett(L-B) method, microemulsions.

REFERENCE BOOKS:

1. Introduction to Nanoscience and Nanotechnology – K.K. *Chatopadhyay and A.N. Benerjee*, PHI

2. Nanotechnology: Principles and Practices – *Sulabha K Kulkarni.* Capital Publishing Company, New Delhi.
3. Nanostructured Materials and Nanotechnology – *Hari Singh Nalwa.* AP.
4. Nanostructures and Nanomaterials-Synthesis, Properties and Applications – *Cao,* Guozhong. World Scientific Series in Nanoscience and Nanotechnology: Volume 2
5. Biological Synthesis of Nanoparticles and Their Applications Edited by L Karthik, A. Vishnu Kirthi, Shivendu Ranjan, V. Mohana Srinivasan, CRC Press
6.Introduction to Nanoscience and Nanomaterials, https://doi.org/10.1142/8433, Dinesh C Agrawal (Indian Institute of Technology, India) World Scientific.

SUGGESTED WEB SOURCES:

1. https://nptel.ac.in/courses/103/106/103106162/
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

CO-PO matrix for the course MPM304 (Fundamentals and Synthesis of Nanomaterials)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4	PSO5
MPM304.1	3	2	3	3	2	3	2	3	3	2	2	3	3	2	3	3
MPM304.2	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3
MPM304.3	3	3	3	3	3	3	2	3	3	2	3	3	3	2	3	3
MPM304.4	3	3	2	2	3	3	3	3	3	3	3	3	3	3	3	3
MPM304.5	3	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3
MPM304.6	3	3	2	2	3	3	3	3	3	3	3	3	3	3	3	3
MPM304.7	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
MPM304.8	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Average	3	2.9	2.6	2.75	2.9	3	2.6	3	3	2.75	2.88	3	3	2.75	3	3

M.Sc. PHYSICS SEMESTER-III

MPM305

SUBJECT NAME: MATERIAL SCIENCE LAB

NO OF CREDITS: 8

L	P		
		SESSIONAL:	30
L	P	END SEM EXAM:	70
0	16	TOTAL:	100

COURSE OUTCOME (COs):

After successful completion of course on Material Science Lab, students will be able to:

MPM305.1 Synthesis the nanomaterial by using Physical and Chemical methods

MPM305.2 Develop the nano tin films by using sputtering method

MPM305.3 Demonstrate the optical properties through a Spectrophotometer

MPM305.4 Demonstrate the structural properties through XRD

MPM305.5 Analyze the material properties through Dynamic light scattering

MPM305.6 Demonstrate the electrical properties using IV and CV Characteristics

MPM305.7 Characterize the nanomaterials Demonstrate the morphology through SEM

MPM305.8 Handle the equipments and Interpret the results through graphs and calculations

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

List of Experiments Material Science Laboratory

1. To study the magneto resistance behavior of Ge crystal at room temperature
2. Synthesis of nanoparticles using Sol-Gel Method
3. Fabrication of thin film using spin coating technique.
4. Preparation of Thin film by Sputtering method
5. Fabrication of Nano/micro pores in Silicon Wafer through Chemical etching technique of porous silicon.
6. Determination of lattice parameters using XRD Technique.
7. Determine the crystallite size of nanomaterial using Debye Scherer method.

8. Determination of band gap energy of metal-oxide nanoparticles using UV Spectrophotometer.
9. To understand the microstructural features of ceramics/metals by optical microscopy.
10. Study and analysis of FTIR spectra of material.
11. To study the I-V characteristics of semiconductor material.
12. To study the C-V characteristics of materials for electrochemical applications
13. Study of surface morphology of a material by scanning electron microscopy (SEM) technique

Experiments may be added or deleted

The faculty conducting the laboratory will prepare a list of 8 experiments and get the approval of the HoD/Director and notify it at the beginning of each semester.

SUGGESTED WEB SOURCES:

1. https://nptel.ac.in/courses/103/106/103106162/
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

CO-PO matrix for the course MPM305 (Materials Science Specialization Lab)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4	PSO5
MPM305.1	3	3	1	2	2	2	1	1	2	2	2	3	2	3	2	3
MPM305.2	3	3	1	2	2	3	2	1	1	2	2	3	3	3	3	3
MPM305.3	3	3	-	1	2	2	1	1	2	2	2	3	3	3	2	3
MPM305.4	3	3	1	2	2	2	2	1	1	2	2	3	3	3	3	3
MPM305.5	3	3	-	1	2	1	1	1	2	2	2	3	2	3	2	3
MPM305.6	3	3	1	3	2	3	2	2	2	2	2	3	3	3	3	3
MPM305.7	3	3	1	3	2	3	1	1	2	2	2	3	3	3	3	3
MPM305.8	3	3	-	3	2	3	2	1	2	2	3	3	3	3	3	3

Average	3	3	0.625	0.875	2.375	2.375	1.5	1.125	1.75	2	2.125	3	2.75	3	2.625	3

M.Sc. PHYSICS SEMESTER-IV

MPM403

SUBJECT NAME: ADVANCED MATERIALS SCIENCE

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 2 marks each. It should cover the entire syllabus. Part II will consist of six questions of 10 marks each out of which the student has to attempt any four.

Course Outcomes (COs)

After successful completion of the course on Material Science-II, a student will be able to:

MPM403.1 *Gain knowledge of the microstructure of the materials.*

MPM403.2 *Grasp the concepts of phase diagrams and phase transformations and correlate these with growth kinetics and microstructure evolution in materials.*

MPM403.3 *Analyze the diffusion process in materials.*

MPM403.4 *Understand superconductivity properties of materials.*

MPM403.5 *Elucidate the different types of composite materials and develop state of art in hybrid and advanced composite materials.*

MPM403.6 *Comprehend the importance of smart and composite materials as futuristic materials.*

MPM403.7 Grasp the concept, working and applications of smart materials for energy harvesting.

MPM403.8 Design the materials for various industrial applications.

Unit I: Phase diagrams and phase transformations (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, Eutectoid mixture; Diffusion: Fick's law, Kirkendall Effects, Atomic Model of Diffusion, Nernst-Einstein relation Phase Transformation: Nucleation, Growth and Overall Transformation Kinetics

Unit-II: Superconductivity (12 hrs.)

Superconductivity and its Occurrence, Meissner effect, Type I and type II Superconductors, London Equation, Coherence Length, Flux Quantization in a Superconducting Ring, Microscopic theory: Qualitative features of the BCS theory; Single Particle Tunneling; DC and AC Josephson Effects; High T_c Superconductors (introduction only).

Unit-III: Composite Materials (12 hrs.)

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, Metal Matrix Composites and Wood Composites, Nanocomposites, Advantages and Limitations of Composites.

Unit-IV: Smart Materials (12 hrs.)

Introduction to Smart Materials, Principles of Piezoelectricty, Perovskite Piezoceramic Materials, Piezoelectric Polymers, Multiferroics and Magnetoelectrics, Smart Actuators, Principles of Magnetostriction, Rare earth Magnetostrictive materials, Giant Magnetostriction and Magneto-resistance Effect, Shape Memory Alloys.

REFERENCES:

1. J.C. Anderson, K.D. Leaver, P. Leevers and R.D. Rawlings, Materials Science for Engineers, CRC Press, London.

2. V. Raghavan, Materials Science and Engineering: A First Course, PHI Learning, New Delhi.
3. C. Kittel, Introduction to Solid State Physics, Wiley, India.
4. A.J. Dekker, Solid State Physics, Macmillan Press, London.
5. M. Tinkham, Introduction to Superconductivity, Dover Publication, New York.
6. W.D. Callister, Materials Science and Engineering : An Introduction, John Wiley, New York.
7. K.K. Chawla, Composite Materials: Science and Engineering, Springer, New York.
8. M. Balasubramaniam, Composite Materials and Processing, CRC Press, New York.
9. D. Hull and T.W. Clyne, Introduction to Composite Materials, Cambridge University Press, U.K.
10. I.A. Parinov, S.H. Chang and V.Y. Topolov, Advanced Materials: Manufacturing, Physics, Mechanics and Applications, Springer, New York.

SUGGESTED WEB SOURCES:

1. https://nptel.ac.in/courses/103/106/103106162/
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

CO-PO matrix for the course MPM403 (Advanced Materials Science)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4	PSO5
MPM403.1	3	3	1	2	2	2	1	1	2	2	2	3	1	-	1	2
MPM403.2	3	3	1	2	2	3	2	1	1	2	2	3	3	-	3	3
MPM403.3	3	3	-	1	2	2	1	1	2	2	2	3	3	-	3	3
MPM403.4	3	3	1	2	2	2	2	1	1	2	2	3	2	-	2	3
MPM403.5	3	3	-	1	2	1	1	1	2	2	2	3	3	-	3	3
MPM403.6	3	3	1	3	2	3	2	2	2	2	2	3	3	-	3	3

MPM403.7	3	3	1	3	2	3	1	1	2	2	2	3	3	-	3	3
MPM403.8	3	3	-	3	2	3	2	1	2	2	3	3	3	-	3	3
Average	3	3	0.625	0.875	2.375	2.375	1.5	1.125	1.75	2	2.125	3	2.625	-	2.625	2.875

M.Sc. PHYSICS SEMESTER-IV

SUBJECT NAME: VACUUM SCIENCE AND THIN FILMS TECHNOLOGY

MPM404

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 2 marks each. It should cover the entire syllabus. Part II will consist of six questions of 10 marks each out of which the student has to attempt any four.

COURSE OUTCOMES:

After successful completion of course on Material Science Lab, students will be able to:

MPM404.1 Understand the fundamentals of vacuum science & Technology

MPM404.2 Develop the knowledge of vacuum production and its measurement.

MPM404.3 Acquitant with various vacuum pumps and leak detection.

MPM404.4 Evolution and fundamentals of thin film technology

MPM404.5 Provide the knowledge about various methods of thin films deposition.

MPM404.6 Fabricate the thin films of materials via various techniques

UNIT–I: Vacuum Fundamentals and Its Production (12 hrs.)

Kinetic theory of gases, Mean free path, Mass flow, Pumping speed, Importance of Vacuum, Design, Principles, Construction, Operational Characteristics and the uses of Rotary pump, Roots pump, Turbomolecular pump, Diffusion pumps, Cryogenic-pump, Sputter-ion pump.

UNIT-II: Vacuum Measurement and Detection (12 hrs.)

Importance of measurement of Pressure, Concept of different gauges: McLeod gauge, thermal conductivity gauges, spin rotor gauge, Ionization gauges, hot cathode, cold cathode gauges; Pirani, Penning and pressure control, Flow Meters and Residual Gas Analyzer, Leak Detection.

UNIT-III: Introduction and preparation of thin film (12 hrs.)
Environment for Thin Film Deposition, Evolution of Thin Film: Absorption (Physisorption), Surface Diffusion, Chemical Bond Formation (Chemisorption), Nucleation, Microstructure Formation, Deposition Parameters and their effects on Film Growth, Epitaxy–homo, hetero and coherent epilayers, lattice misfit and imperfections.

UNIT-IV: Thin Film Deposition techniques (12 hrs.)
Thermal evaporation, Electron beam evaporation, DC and RF Sputtering Technique: Bias sputtering, magnetically enhanced sputtering systems, reactive sputtering, Chemical Vapour Deposition (CVD), Pulsed Laser Deposition (PLD), Atomic layer deposition (ALD), Spin Coating, Spray pyrolysis, Molecular beam epitaxy.

REFERENCE BOOKS:

1. Vacuum Science and Engineering, CM Van Atta, Tata McGraw Hill, New York.
2. Vacuum Technology, Andrew Guthrie, Wiley, New York.
3. Vacuum Technology – An introduction by LG Carpenter
4. Thin Film Phenomenon, K. L. Chopra, McGraw Hill, New York.
5. Vacuum Physics and Techniques, T. A. Delchar, Chapman & Hall.

SUGGESTED WEB SOURCES:

1. https://nptel.ac.in/courses/103/106/103106162/
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

CO-PO matrix for the course MPM404 (Vacuum Science and Thin film Technology)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4	PSO5
MPM404.1	3	2	2	3	2	2	2	2	2	2	2	3	1	-	1	2

MPM404.2	3	3	2	3	2	2	3	3	2	2	2	3	3	-	3	3
MPM404.3	3	2	3	2	2	3	2	2	2	2	2	3	3	-	3	3
MPM404.4	3	2	2	2	3	2	2	2	1	3	2	3	2	-	2	3
MPM404.5	3	3	2	3	3	3	3	3	2	3	3	3	3	-	3	3
MPM404.6	3	3	2	2	3	2	3	2	3	2	3	3	3	-	3	3
Average	3	2.5	2.2	2.5	2.5	2.3	2.5	2.3	2	2.5	2.3	3	2.625	-	2.625	2.875

SPECIALIZATION-III: ELECTRONICS

M.Sc. PHYSICS III SEM

MPE303

SUBJECT NAME: ANALOG ELECTRONICS

NO OF CREDITS: 4

L	P		
		SESSIONAL:	25
		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 OUTCOMES: *After successfully completing of the course, students will be able to,*

MPE303.1 Describe and explain working of microwave tubes and solid state devices..

MPE303.2 Explain the operation of RADAR systems and recite their applications.

MPE303.3 Undetrstand various modulation and demodulation techniques.

MPE303.4 Learn the communication satellite mechanics

UNIT –I Microwave Electronics (12 hrs)

Microwave characteristic features & applications, Waveguide and cavity resonators, Two cavities Klystron, Reflex Klystron, Gunn diode characteristics, microwave antenna, Detection of microwave, Dielectric constant measurement, Isolator and circulator, PIN diode modulator, Directional coupler, Avalanche Transit Time Devices: IMPATT Diode-Physical structure, Principle of operation, breakdown voltage, Avalanche and Drift region.

UNIT –II Radar Communication (12 hrs)

Basic Radar systems, Radar range equation and performance factor, Radar Cross-section, Pulsed Radar system, Duplexer, Radar display, Doppler Radar, CWIF Radar, FMCW Radar, Moving Target Indicator (MTI), Blind Speeds.

UNIT –III Analog Signal Transmission (12 hrs)

Introduction, Amplitude, Frequency & phase modulation; AM, FM modulating and demodulating circuits; AM, FM Receivers functioning (Block Diagram) and characteristic features; Pulse modulation; Sampling Processes, PAM, PWM and PPM modulation and demodulation, Quantization noise, PCM, Differential PCM and Delta modulation systems, Comparison of PCM and PDM, Time division multiplexing.

UNIT –IV Satellite Communication (12 hrs)

Principle of Satellite communication, Satellite frequency allocation and band spectrum, Satellite orbit, trajectory and its stability, Satellite link Design, Elements of Digital Satellite Communication, Multiple Access Technique, Antenna system, Transponder, Satellite Applications.

REFERENCE BOOKS:

1. Digital and Analog Communication Systems : K. San Shanmugam, John Wiley and Sons.
2. Communication Systems : Simon Haykin, John Wiley and Sons
3. Principles of Communication System, H. Taub and D.L. Schilling, TMH
4. Electronic Communication System, G. Kennedy, B. Davis and S.R.M. Prasanna, TMH
5. Microwave and Radar Engineering : M.Kulkarni.
6. Satellite Communication : Pratt and Bosterin.
7. Microwave : K.C. Gupta.

SUGGESTED WEB SOURCES:

1. https://nptel.ac.in/courses/103/106/103106162/

2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

CO-PO matrix for the course MPE303 (Analog Electronics)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4	PSO5
MPE303.1	3	2	2	3	2	3	3	3	3	2	3	3	1	-	1	2
MPE303.2	3	2	2	3	2	3	3	3	3	2	3	3	3	-	3	3
MPE303.3	3	2	2	3	2	3	3	3	3	2	2	3	3	-	3	3
MPE303.4	3	2	2	3	2	3	3	3	3	2	3	3	2	-	2	3
Average	3	2	2	3	2	3	3	3	3	2	3	3	3	-	3	3

M.Sc. PHYSICS SEMESTER-III
MPE 304

SUBJECT NAME: MICROPROCESSOR

NO OF CREDITS: 4

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

Note: The question paper will be of two parts. Part I will consist of 10 questions of 2 marks each. It should cover the entire syllabus. Part II will consist of six questions of 10 marks each out of which the student has to attempt any four.

COURSE OUTCOMES:
After successful completion of the course, student shall be able to

MPE304.1 Understand the basics of microprocessor and 8085 microprocessor.

MPE304.2 Understand of the Intel 8086 architecture. Knowledge of the 8086 instruction set and ability to utilize it in programming.

MPE304.3 Learn addressing modes (Immediate, direct, extended, indexed modes).

MPE304.4 Understand the Intel 8086 real mode memory addressing.

MPE304.5 Ability to interface various devices to the microprocessor. Introduction to the microcontroller.

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: 8086 Microprocessor 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.

REFERENCE BOOKS:

1. Liu and Gibson: Microprocessor System the 8086 / 8088 Family
2. D.V. Hall: Microprocessor and Interfacing, 3rd edition, McGraw-Hill Education - Europe
3. B. Ram: Fundamentals of Microprocessor, Dhanpat Rai Publications

SUGGESTED WEB SOURCES:

1. https://nptel.ac.in/courses/103/106/103106162/

2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

CO-PO matrix for the course MPE304 (Microprocessor)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4	PSO5
MPE303.1	3	2	2	3	2	3	3	3	3	2	3	3	1	-	1	2
MPE303.2	3	2	2	3	2	3	3	3	3	2	3	3	3	-	3	3
MPE303.3	3	2	2	3	2	3	3	3	3	2	2	3	3	-	3	3
MPE303.4	3	2	2	3	2	3	3	3	3	2	3	3	2	-	2	3
Average	3	2	2	3	2	3	3	3	3	2	3	3	3	-	3	3

M.Sc. PHYSICS SEMESTER-III

MPE305

SUBJECT NAME: ELECTRONICS SPECIALIZATION LAB

CREDIT: 8

L	P		
		SESSIONAL:	30
		END SEM EXAM:	70
0	16	TOTAL:	100

COURSE OUTCOME:

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

MPE305.1 understand the operation and design of digital system.

MPE305.2 work on microprocessor, interfacing & programming on pc.

MPE305.3 Have practical knowledge and develop skill in digital system & microprocessor.

MPE305.4 Have working knowledge of microwave test bench & measurements.

MPE305.5 Understand modulation and demodulation

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

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
12. Resonant circuits
13. Filters: Active and passive (All pass)
14. Power supply regulation and stabilisation
15. Oscillator : design and study
16. Multivibrator: astable, monostable, bistable
17. Design and study of triangular wave generator.

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

SUGGESTED WEB SOURCES:

1. https://nptel.ac.in/courses/103/106/103106162/
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

CO-PO matrix for the course MPE305 (Electronics Specialization lab)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4	PSO5
MPE305.1	3	2	2	3	2	2	2	2	2	2	2	3	1	-	1	2

MPE305.2	3	3	2	3	2	2	3	3	2	2	2	3	3	-	3	3
MPE305.3	3	2	3	2	2	3	2	2	2	2	2	3	3	-	3	3
MPE305.4	3	2	2	2	3	2	2	2	1	3	2	3	2	-	2	3
MPE305.5	3	3	2	3	3	3	3	3	2	3	3	3	3	-	3	3
Average	3	2.5	2.2	2.5	2.5	2.3	2.5	2.3	2	2.5	2.3	3	2.625	-	2.625	2.875

M.Sc. PHYSICS SEMESTER-IV

MPE403

SUBJECT NAME: DIGITAL ELECTRONICS

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 Outcomes (COs)

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

MPE403.1 Understand mathematical description and representation of discrete and continuous time signal and systems.

MPE403.2 Understand the basics of information and coding theories.

MPE403.3 Understand the signal flow in digital communication system.

MPE403.4 Understand basic elements of optical fiber transmission, fiber modes and various optical detectors.

UNIT - I Signals, System and Noise (12 hrs)

Basics Elements of Communication Systems, Fourier Representation of Periodic and Non-Periodic Signals, Impulse And Step Response of Systems, Time and Frequency Domain Analysis of Systems, Ideal and Real Filters, Noise in Communication Systems, Signal To Noise Ratio, Noise Equivalent Bandwidth and Noise Figure.

UNIT – II Information Technology and Coding (12 hrs)

Introduction, Amount of Information, Average Information, Shannon Encoding Algorithm, Communication Channels, Rate of Information And Capacity of Discrete Memory less Channels, Shanon-Hartley Theorem. Linear Block Cyclic Codes.

UNIT – III Digital Signal (Data) Transmission (12 hrs)

Introduction, Optimum Receiver For Binary Digital Modulation Schemes, Binary ASK, Binary FSK, Binary PSK And Differential PSK Signaling Schemes, Serial Data Communication in Computers USART 8251, Basics Communication Networks(LAN,WAN,MAN) And Its Topology

UNIT – IV Fibre Optic Communication (12 hrs)

Basic Optical Communication System, Wave Propagation in Optical Fibre Media, Step and Graded Index Fiber, Material Dispersion And Mode Propagation, Losses in Fibre, Optical Fibre Sources (LEDs and LASERs) And Detectors (PIN Photodiode, APD Photodiode), Optical Joints And Couplers

REFERENCE BOOKS:

1. Digital and Analog Communication Systems: K. San Shanmugam.
2. Communication Systems: Simon Haykin.
3. Optical Fibre Communication: Kaiser.

SUGGESTED WEB SOURCES:

1. https://nptel.ac.in/courses/103/106/103106162/
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

CO-PO matrix for the course MPE403 (Digital Electronics)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4	PSO5
MPE403.1	3	2	2	3	2	3	3	3	3	2	3	3	2	-	2	1

MPE403.2	3	2	2	3	2	3	3	3	3	2	3	3	1	-	3	3
MPE403.3	3	2	2	3	2	3	3	3	3	2	2	3	2	-	2	2
MPE403.4	3	2	2	3	2	3	3	3	3	2	3	3	2	-	2	3
Average	3	2	2	3	2	3	3	3	3	2	3	3	2	-	2	3

M.Sc. PHYSICS SEMESTER-IV

MPE404

SUBJECT NAME: OPTICAL FIBER COMMUNICATION

NO OF CREDITS: 4

L	P		
		SESSIONAL:	25
		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 Outcomes: *After the successful completion of the course, students will be able to*

MPE 404.1: Understand optical fiber waveguides and their applications.

MPE 404.2: Comprehend the use of input/output devices in optical fiber communication.

MPE 404.3 Understand the transmission characteristics of optical fibers.

MPE 404.4 Develop a clear understanding of optical fiber communication, fiber technology and Sensor devices.

MPE 404.5 Analyse the difference between different optical sources.

MPE 404.6 Construct designs for PCFs, OFCSD.

Unit I : Optical Fiber Waveguides (12hrs)

Introduction: Principle of Light Transmission in a fiber, Ray theory transmission, Total Internal Reflection, Numerical Aperture, Skew rays and meridional rays: Electromagnetic mode theory for optical propagation: Modes in a planar waveguide, Group velocity and phase velocity, group index; Fiber index profiles: multi-mode step-index fibers, multi-mode graded index fibers, single mode step index fibers; Photonic Crystal fibers: Index guiding micro-structures and Photonic Band gap fibers.

Unit II: Input / Output Devices (12hrs)

Optical sources; the Laser, Basic concepts, Absorption and Emission of radiation, Einstein's coefficients, semiconductor laser, light emitting diode, the semiconductor junction diode; non-semiconductor lasers: Nd:Yag laser, Ruby laser He-Ne laser; Optical detectors: principle, important parameters of ODs, Absorption coefficient, Quantum efficiency efficiency and responsivity, long wavelength cut-off; semiconductor photodiodes without internal gain: pn photo diode, PIN photodiode; semiconductor photodiodes with internal gain; Avalanche Photo diode

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

Attenuation, Material absorption losses in optical fibers; Intrinsic and Extrinsic absorption losses, fiber bend losses, linear scattering losses, Rayleigh scattering, Mie scattering, non-linear scattering losses: Stimulated Brillouin Scattering (SBS), Stimulated Raman Scattering (SRS), Dispersion: Chromatic dispersion, Material dispersion, Wave guide dispersion, inter-modal dispersion in Multimode step index fibers and graded index fibers, Intra-modal dispersion, modal noise.

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

Fiber materials, glass fibers, active glass fibers, plastic clad fibers, plastic optical fibers (POF), Preparation of optical fibers, Fiber fabrication: Liquid phase melting techniques, fiber drawing Outside Vapor- phase oxidation, Vapor-phase Axial deposition, modified chemical vapor deposition, Plasma activated chemical vapor deposition; Principle components of an Optical Fiber Communication System: optical sources, optical detectors, optical amplifier, fiber couplers, directional couplers, Elementary idea of Optical Fiber Sensors.

REFERENCE BOOKS:

1. Ghatak and Thyagrajan: Introduction to Fiber Optics: Cambridge University Press
2. Keiser: Optical Fiber Communication: McGraw Hill Education, edition 2017

3. Gowar: Optical Communication System; Prentice Hall International
4. Sapna Katiyar: Optical Fiber Communication: S.K. Kataria and Sons, 2013
5. Senior: Optical Fiber Communication: Principles and Practices: Pearson, Edition 3, 2010

SUGGESTED WEB SOURCES:

1. https://nptel.ac.in/courses/103/106/103106162/
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

CO-PO matrix for the course MPE404 (Optical Fiber Communication)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4	PSO5
MPE404.1	3	2	2	3	3	3	2	3	2	2	2	3	3	2	3	3
MPE404.2	3	3	3	3	3	3	2	3	3	3	3	3	3	2	3	3
MPE404.3	3	3	3	2	2	3	3	3	2	2	2	3	3	3	3	3
MPE404.4	3	2	3	2	2	3	3	2	3	3	2	3	3	2	3	3
MPE404.5	3	1	2	3	3	3	2	3	2	2	3	3	3	2	3	3
MPE404.6	3	2	3	2	3	3	2	2	2	3	2	3	3	2	3	3
Average	3	2.17	2.67	2.5	2.67	3	2.34	2.67	2.34	2.5	2.34	3	3	2.16	3	3

AUDIT COURSE

APH101

SUBJECT NAME: RENEWABLE ENERGY RESOURCES

NO OF CREDITS: 2

L	P		
		SESSIONAL:	25
		THEORY EXAM:	75
2	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 OUTCOMES (COs)

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

APH 101.1: Learn the importance of alternate energy sources.

APH 101.2: Understand the fundamentals of renewable energy resources.

APH 101.3: Understand the principles of solar energy and its environmental impact.

APH 101.4: Learn the basics of solar energy collection and storage.

APH 101.5: Study the basics of wind energy and geothermal energy.

APH 101.6: Comprehend the use of ocean energy as an alternate source of energy.

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; Geothermal 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.

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)

SUGGESTED WEB SOURCES:

1. https://nptel.ac.in/courses/103/106/103106162/
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

CO-PO matrix for the course APH 101 (Renewable Energy Sources)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4	PSO5
APH101.1	3	2	2	3	3	3	2	3	2	2	2	3	3	2	3	3
APH101.2	3	3	3	3	3	3	2	3	3	3	3	3	3	2	3	3
APH101.3	3	3	3	2	2	3	3	3	2	2	2	3	3	3	3	3
APH101.4	3	2	3	2	2	3	3	2	3	3	2	3	3	2	3	3
APH101.5	3	1	2	3	3	3	2	3	2	2	3	3	3	2	3	3
APH101.6	3	2	3	2	3	3	2	2	2	3	2	3	3	2	3	3
Average	3	2.17	2.67	2.5	2.67	3	2.34	2.67	2.34	2.5	2.34	3	3	2.16	3	3

OPEN ELECTIVE COURSE

OPH101

SUBJECT NAME: 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 OUTCOMES (COs):

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

OPH 101.1 : Understand how the properties of astronomical objects and the Universe relate to simple physical laws and processes

OPH 101.2 : Understand the role and physics of detectors and telescopes including geometric optics and understand how distances are measured.

OPH 101.3 : Know how basic laws of physics determine the properties and evolution of stars.

OPH 101.4 : Know Kepler's Laws and how they relate to extrasolar planet detection.

OPH 101.5 : Construct the dynamics of galaxies, the presence of dark matter

OPH 101.6 : Understand the evolution of our Universe.

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, 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.

REFERENCES:

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

SUGGESTED WEB SOURCES:

1. https://nptel.ac.in/courses/103/106/103106162/
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

CO-PO matrix for the course OPH101 (Introduction to Astro Physics and Cosmology)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4	PSO5
OPH101.1	3	2	2	3	2	2	2	2	2	2	2	3	3	2	3	3
OPH101.2	3	3	1	3	2	2	3	2	2	2	2	3	3	2	3	3
OPH101.3	3	2	3	2	2	3	2	1	2	2	2	3	3	3	3	3
OPH101.4	3	2	1	2	3	2	2	2	1	3	2	3	3	2	3	3
OPH101.5	3	3	1	3	3	3	3	2	2	3	3	3	3	2	3	3
OPH101.6	3	3	2	2	3	2	3	2	3	2	3	3	3	2	3	3

Average	3	2.5	1.7	2.5	2.5	2.3	2.5	1.8	2	2.5	2.3	3	3	2.16	3	3

OPEN ELECTIVE COURSE

OPH102

SUBJECT NAME: ENERGY HARVESTING AND STORAGE DEVICES

NO OF CREDITS: 3

L	P		
		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 OUTCOMES (COs):

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

OPH 102.1:Understand the use of nanomaterials in energy generation and storage devices.
OPH 102.2: Exhibit understanding of the sources of energy and the methods of energy conversion and storage.
OPH 102.3 :Comprehend the principles behind energy storage mechanisms.

OPH 102.4 :Gain a broad understanding of concepts and applications of Solar and renewable energy.
OPH 102.5 Design and fabricate solar cells, hydroelectric cells and electrochemical storage devices.
OPH 102.6 Fabricate energy storage devices e.g. Supercapacitors and Batteries.

UNIT-I: Introduction

Energy challenges, Energy consummation, Current sources of energy, Status of energy map, Energy policies, Conservation of energy, Alternative energy sources, Development and implementation of renewable energy technologies, role of renewable energy sources, Energy transport, conversion and storage, Sustainable Energy.

UNIT-II: Solar Energy

Fundamentals of solar cells, Types of solar cells, Photovoltaic effect, Semiconducting materials bandgap theory, Band gap engineering, Solar cell properties and design, p-n junction, Photodiodes, electron and hole transports, charge carrier generation, recombination, I-V characteristics, Tandem structure, Single junction and triple-junction, solar panels, thin film solar cells, solar cell applications, solar cell manufacturing process.

UNIT-III: Thermoelectric, Piezoelectric and Hydroelectric Energy

Thermoelectric and Piezoelectric materials, Fabrication and characterization of thermoelectric devices, Bulk thermoelectric materials performance, Thermoelectric modules, Piezoelectric harvester design, Micro and nanoscale energy harvesting, Fabrication and characterization of piezoelectric devices, Principal and working of Hydroelectric cell, Future prospects of Hydroelectric cell.

UNIT-IV: Electrochemical Energy Storage Devices

Primary and secondary cells, Chemistry and material used for various components (electrode, electrolytes, separator and binders) of different types of batteries: Ni-Hydrogen battery, Sodium-sulfur battery, Lithium-ion/Lithium-polymer battery, Metal-air batteries and its applications., Fundamentals of Electrochemical supercapacitors,, Electrostatic Double Layer Capacitor, Pseudocapacitor, Fabrication of Hybrid supercapacitor, Electrode and electrolytes interfaces and their capacitances, Charge-Discharge characteristics, Energy and Power density, Design, Fabrication and operation, Future prospects of batteries and supercapacitors.

REFERENCE BOOKS

1. Energy for a sustainable world by L. Freris, D. Infield, Wiley, 2008.
2. Nanomaterials for Sustainable Energy by Quan (Ed.), Springer, 2016.
3. Nanomaterials in Energy Devices by Jun Hieng Kait CRC Press, 2017.
4. Advanced nanomaterials and their applications in renewable energy by J. Louise, L. S. Bashir, 2015.
5. Energy Storage and Conversion Devices: Supercapacitors, Batteries, and Hydroelectric Cells by A. Gaur, AL Sharma, A Arya, CRC Press Taylor & Francis Group, 2021.

SUGGESTED WEB SOURCES:

1. https://nptel.ac.in/courses/103/106/103106162/
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

CO-PO matrix for the course OPH102 (Energy Harvesting and Storage Devices)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4	PSO5
OPH102.1	3	2	2	3	2	2	2	2	2	2	2	3	3	2	3	3
OPH102.2	3	3	1	3	2	2	3	2	2	2	2	3	3	2	3	3
OPH102.3	3	2	3	2	2	3	2	1	2	2	2	3	3	3	3	3
OPH102.4	3	2	1	2	3	2	2	2	1	3	2	3	3	2	3	3
OPH102.5	3	3	1	3	3	3	3	2	2	3	3	3	3	2	3	3
OPH102.6	3	3	2	2	3	2	3	2	3	2	3	3	3	2	3	3
Average	3	2.5	1.7	2.5	2.5	2.3	2.5	1.8	2	2.5	2.3	3	3	2.16	3	3

Mapping of the subjects with the following

S. No.	Course Name	Course code	Employability	Entrepreneurship	Skill Development
1	Mathematical Physics	MPH101	√		
2	Classical Mechanics	MPH102	√		
3	Quantum Mechanics-I	MPH103	√		
4	Electronic Devices	MPH104	√	√	√
5	Physics Laboratory-I	MPH105	√	√	√
6	Seminar-I	MPH106	√	√	√
7	Quantum Mechanics - II	MPH201	√		
8	Nuclear and Particle Physics	MPH202	√		
9	Solid State Physics	MPH203	√		
10	Electrodynamics	MPH204	√		

11	Physics Laboratory-II	MPH205	√	√	√
12	Atomic and Molecular Physics	MPH301	√		
13	Statistical Mechanics	MPH302	√		
14	Laser Technology	MPH401	√	√	√
15	Materials Science	MPH402	√	√	√
16	Dissertation	MPH405	√	√	√
17	Nuclear Reactions	MPN303	√		
18	Nuclear Detectors	MPN304	√	√	√
19	Nuclear Physics Spec. Lab	MPN305	√	√	√
20	Nuclear Models and Astrophysics	MPN403	√		
21	Nuclear Techniques and Neutron Physics	MPN404	√		
22	Materials Characterization Techniques	MPM303	√	√	√
23	Fundamentals and synthesis of nanomaterials	MPM304	√	√	√
24	Material Science Spec. Lab	MPM305	√	√	√
25	Advanced Materials Science	MPM403	√	√	√
26	Vacuum Science and Thin Films Technology	MPM404	√	√	√
27	Analog Electronics	MPE303	√	√	√
28	Microprocessor	MPE304	√	√	√
29	Electronics Spec. Lab	MPE305	√	√	√
30	Digital Electronics	MPE403	√	√	√
31	Optical fiber Communication	MPE404	√	√	√
32	RENEWABLE ENERGY RESOURCES	APH101	√	√	√
33	INTRODUCTION TO ASTROPHYSICS AND COSMOLOGY	OPH101	√		

34	ENERGY HARVESTING AND STORAGE DEVICES	OPH102	√	√	√

B.Sc. (H) Physics

Scheme and Syllabus

Outcome Based Education System (OBES)/

Learning Outcomes based Curriculum Framework (LOCF)

Choice Base Credit System (CBCS)

ACADEMIC SESSION

(w.e.f. 2021-2022)

DEPARTMENT OF PHYSICS

FACULTY OF SCIENCES

J C BOSE UNIVERSITY OF SCIENCE AND TECHNOLOGY, YMCA, FARIDABAD HARYANA -121006

J C BOSE UNIVERSITY OF SCIENCE AND TECHNOLOGY, YMCA, FARIDABAD

VISION

"J.C BOSE University of Science and Technology, YMCA, Faridabad 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.

DEPARTMENT OF PHYSICS

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 the 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.

Aims of the bachelor's degree programme in Physics with honours

The overall aims of the bachelor's honors degree programme in physics are to:

- 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 applications.
- Developing creative thinking and the power of imagination to enable the graduates to work in research in academia and industry for broader application.
- Accommodating their relevant fields in allied disciplines and allowing the graduates of Physics to fit into the interdisciplinary 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 undergraduate level. Apart from the general topics in physics, many of the new topics included in the syllabus keep the students abreast with the latest developments taking place in the field. Also, the experiments chosen for each practical course are 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 OF UG PROGRAM OF FACULTY OF SCIENCES

PO1	Disciplinary knowledge	Capable of demonstrating comprehensive knowledge and understanding of one or more disciplines that form a part of an undergraduate programme of study.
PO2	Communication Skills	Ability to express thoughts and ideas effectively in writing and orally; Communicate with others using appropriate media; confidently share one‟s views and express herself/himself; demonstrate the ability to listen carefully, read and write analytically, and present complex information clearly and concisely to different groups.
PO3	Critical thinking	Capability to apply analytic thought to a body of knowledge; analyze and evaluate evidence, arguments, claims, beliefs on the basis of empirical evidence; identify relevant assumptions or implications; formulate coherent arguments; critically evaluate practices, policies, and theories by following a scientific approach to knowledge development.
PO4	Problem solving	Capacity to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems, rather than replicate curriculum content knowledge; and apply one‟s learning to real-life situations.
PO5	Analytical reasoning	Ability to evaluate the reliability and relevance of evidence; identify logical flaws and holes in the arguments of others; analyze and synthesize data from a variety of sources; draw valid conclusions and support them with evidence and examples, and address opposing viewpoints.
PO6	Research-related skills	A sense of inquiry and capability for asking relevant/appropriate questions, problematizing, synthesizing, and articulating; Ability to recognize cause-and-effect relationships, define problems, formulate hypotheses, test hypotheses, analyze, interpret and draw conclusions from data, establish hypotheses, predict cause-and-effect relationships; ability to plan, execute and report the results of an experiment or investigation.

PO7	Cooperation/Teamwork	Ability to work effectively and respectfully with diverse teams; facilitate cooperative or coordinated effort on the part of a group, and act together as a group or a team in the interests of a common cause and work efficiently as a member of a team.
PO8	Scientific reasoning	Ability to analyze, interpret and draw conclusions from quantitative/qualitative data; and critically evaluate ideas, evidence, and experiences LOCF 4 from an open-minded and reasoned perspective.
PO9	Reflective thinking	Critical sensibility to lived experiences, with self-awareness and reflexivity of both self and society.
PO10	Information/digital literacy	Capability to use ICT in a variety of learning situations, demonstrate ability to access, evaluate, and use a variety of relevant information sources; and use appropriate software for analysis of data.
PO11	Self-directed learning	Ability to work independently, identify appropriate resources required for a project, and manage a project through to completion.
PO12	Multicultural competence	Possess knowledge of the values and beliefs of multiple cultures and a global perspective; and capability to effectively engage in a multicultural society and interact respectfully with diverse groups.
PO13	Moral and ethical awareness/reasoning	Ability to embrace moral/ethical values in conducting one‟s life, formulate a position/argument about an ethical issue from multiple perspectives, and use ethical practices in all work. Capable of demonstrating the ability to identify ethical issues related to one‟s work, avoid unethical behavior such as fabrication, falsification, or misrepresentation of data or committing plagiarism, not adhering to intellectual property rights; appreciating environmental and sustainability issues; and adopting objective, unbiased and truthful actions in all aspects of work.
PO14	Leadership readiness/qualities	Capability for mapping out the tasks of a team or an organization, and setting direction, formulating an inspiring vision, building a team who can help achieve the vision, motivating and inspiring team members to engage with that vision, and using management skills to guide people to the right destination, in a smooth and efficient way.

PO15	Lifelong learning	Ability to acquire knowledge and skills, including „learning how to learn", that is necessary for participating in learning activities throughout life, through self-paced and self-directed learning aimed at personal development, meeting economic, social, and cultural objectives, and adapting to changing trades and demands of the workplace through knowledge/skill development/reskilling.

Program Specific Outcomes (PSOs)

The program specific outcomes (PSO's) are the statement of competencies/abilities that describes the knowledge and capabilities of the post-graduate will have by the end of program studies.

After successful completion of B. Sc. (H) Physics program, the students will be able to

PSO1	Demonstrates (i) a fundamental/systematic or coherent understanding of the academic field of Physics, its different learning areas and applications, and its linkages with related disciplinary areas/subjects; (ii) Demonstrate procedural knowledge that creates different types of professionals related to the disciplinary/subject area of Physics, including professionals engaged in research and development, teaching and government/public service; (iii) Demonstrate skills in areas related to one's specialisation area within the disciplinary/subject area of Physics and current and emerging developments in the field of Physics.
PSO2	Demonstrates the ability to use Physics skills such as formulating and tackling Physics-related problems and identifying and applying appropriate physical principles and methodologies to solve a wide range of problems associated with Physics.
PSO3	Plan and execute physics-related experiments or investigations, analyse and interpret data/information collected using appropriate methods, including the use of appropriate software such as programming languages and purpose-written packages, and report accurately the findings of the experiment/investigations while relating the conclusions/findings to relevant theories of Physics.

JC BOSE UNIVERSITY OF SCIENCE AND TECHNOLOGY, YMCA, FARIDABAD

DEPARTMENT OF PHYSICS

SCHEME B.SC. (H) PHYSICS

SEMESTER I

Subject Code	Title	L	T	P	Internal Assessment	End-semester Examination	Total	Credits	Category Code
Discipline Core Course (DCC) – Compulsory									
BPH-101A	Mathematical Physics-I	4	0	0	25	75	100	4	DCC
BPH-102A	Mechanics	4	0	0	25	75	100	4	DCC
BPH-103A	Mathematical Physics-I Lab	0	0	4	15	35	50	2	DCC
BPH-104A	Mechanics Lab	0	0	4	15	35	50	2	DCC
Ability Enhancement Compulsory Course (AECC) – Compulsory									
BENG-101A	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-101A	Calculus	5	1	0	25	75	100	6	OEC
OELC-101A	Electronic circuit & PCB Designing	4	0	0	25	75	100	4	OEC
OCSC-101A	Introduction to Programming	4	0	0	25	75	100	4	OEC
OCHE-101A	Inorganic Chemistry	4	0	0	25	75	100	4	OEC
OELC-102A	Electronic circuit & PCB Designing Lab	0	0	4	15	35	50	2	OEC
OCSC-102A	Introduction to Programming Lab	0	0	4	15	35	50	2	OEC
OCHE-102A	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

JC BOSE UNIVERSITY OF SCIENCE AND TECHNOLOGY, YMCA, FARIDABAD

DEPARTMENT OF PHYSICS

SCHEME B.SC. (H) PHYSICS

SEMESTER II

Subject Code	Title	L	T	P	Internal Assessment	End-semester Examination	Total	Credits	Category Code
Discipline Core Course (DCC) – Compulsory									
BPH-201A	Electricity & Magnetism	4	0	0	25	75	100	4	DCC
BPH-202A	Waves & Optics	4	0	0	25	75	100	4	DCC
BPH-203A	Electricity & Magnetism Lab	0	0	4	15	35	50	2	DCC
BPH-204A	Waves & Optics Lab	0	0	4	15	35	50	2	DCC
Ability Enhancement Compulsory Course (AECC) – Compulsory									
BEVS-101A	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-201A	Linear Algebra	5	1	0	25	75	100	6	OEC
OELC-201A	Instrumentation	4	0	0	25	75	100	4	OEC
OCSC-201A	Introduction to Database System	4	0	0	25	75	100	4	OEC
OCHE-201A	Physical Chemistry	4	0	0	25	75	100	4	OEC
OELC-202A	Instrumentation Lab	0	0	4	15	35	50	2	OEC
OCSC-202A	Introduction to Database System Lab	0	0	4	15	35	50	2	OEC
OCHE-202A	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 the University site

JC BOSE UNIVERSITY OF SCIENCE AND TECHNOLOGY, YMCA, FARIDABAD

DEPARTMENT OF PHYSICS

SCHEME B.SC. (H) PHYSICS

SEMESTER III

Subject Code	Title	L	T	P	Internal Assessment	End-semester Examination	Total	Credits	Category Code
Discipline Core Course (DCC) – Compulsory									
BPH-301A	Mathematical Physics-II	4	0	0	25	75	100	4	DCC
BPH-302A	Thermal Physics	4	0	0	25	75	100	4	DCC
BPH-303A	Analog Systems & Applications	4	0	0	25	75	100	4	DCC
BPH-304A	Mathematical Physics-II Lab	0	0	4	15	35	50	2	DCC
BPH-305A	Thermal Physics Lab	0	0	4	15	35	50	2	DCC
BPH-306A	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-01A	Computational Physics Skills	2	0	0	25	75	100	2	SEC
SECP-02A	Electrical Circuits & Network Skills	2	0	0	25	75	100	2	SEC
SECP-03A	Basic Instrumentation Skills	2	0	0	25	75	100	2	SEC
SECP-04A	Computational Physics Skills Lab	0	0	2	15	35	50	0	SEC
SECP-05A	Electrical Circuits & Network Skills Lab	0	0	2	15	35	50	0	SEC
SECP-06A	Basic Instrumentation Skills Lab	0	0	2	15	35	50	0	SEC
SECP-07A	Renewable Energy and Energy Harvesting	2	0	0	25	75	100	2	SEC
SECP-08A	Renewable Energy and Energy Harvesting 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-301A	Differential Equations	5	1	0	25	75	100	6	OEC
OELC-301A	Communication Systems	4	0	0	25	75	100	4	OEC
OCSC-301A	Computer Networks & Internet Technology	4	0	0	25	75	100	4	OEC
OCHE-301A	Organic Chemistry	4	0	0	25	75	100	4	OEC
OELC-302A	Communication Systems Lab	0	0	4	15	35	50	2	OEC

OCSC-302A	Computer Networks & Internet Technology Lab	0	0	4	15	35	50	2	OEC
OCHE-302A	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**	

JC BOSE UNIVERSITY OF SCIENCE AND TECHNOLOGY, YMCA, FARIDABAD

DEPARTMENT OF PHYSICS

SCHEME B.SC. (H) PHYSICS

SEMESTER IV

Subject Code	Title	L	T	P	Internal Assessment	End-semester Examination	Total	Credits	Category Code
Discipline Core Course (DCC) – Compulsory									
BPH-401A	Mathematical Physics-III	4	0	0	25	75	100	4	DCC
BPH-402A	Elements of Modern Physics	4	0	0	25	75	100	4	DCC
BPH-403A	Digital Systems & Applications	4	0	0	25	75	100	4	DCC
BPH-404A	Mathematical Physics-III Lab	0	0	4	15	35	50	2	DCC
BPH-405A	Elements of Modern Physics Lab	0	0	4	15	35	50	2	DCC
BPH-406A	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-01A	Computational Physics Skills	2	0	0	25	75	100	2	AEEC
SECP-02A	Electrical Circuits & Network Skills	2	0	0	25	75	100	2	AEEC
SECP-03A	Basic Instrumentation Skills	2	0	0	25	75	100	2	AEEC
SECP-04A	Computational Physics Skills Lab	0	0	2	15	35	50	0	SEC
SECP-05A	Electrical Circuits & Network Skills Lab	0	0	2	15	35	50	0	SEC
SECP-06A	Basic Instrumentation Skills Lab	0	0	2	15	35	50	0	SEC
SECP-07A	Renewable Energy and Energy Harvesting	2	0	0	25	75	100	2	SEC
SECP-08A	Renewable Energy and Energy Harvesting 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-401A	Numerical Methods	5	1	0	25	100	100	6	OEC
OELC-401A	Microprocessor & Microcontroller Systems	4	0	0	25	75	100	4	OEC
OCSC-401A	Information Security	4	0	0	25	75	100	4	OEC
OCHE-401A	Spectroscopy	4	0	0	25	75	100	4	OEC
OELC-402A	Microprocessor & Microcontroller Systems Lab	0	0	4	15	35	50	2	OEC
OCSC-402A	Information Security Lab	0	0	4	15	35	50	2	OEC
OCHE-402A	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**	

JC BOSE UNIVERSITY OF SCIENCE AND TECHNOLOGY, YMCA, FARIDABAD

DEPARTMENT OF PHYSICS

SCHEME B.SC. (H) PHYSICS

SEMESTER V

Subject Code	Title	L	T	P	Internal Assessment	End-semester Examination	Total	Credits	Category Code
Discipline Core Course (DCC) – Compulsory									
BPH-501A	Quantum Mechanics & Applications	4	0	0	25	75	100	4	DCC
BPH-502A	Solid State Physics	4	0	0	25	75	100	4	DCC
BPH-503A	Quantum Mechanics & Applications Lab	0	0	4	15	35	50	2	DCC
BPH-504A	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-501A	Atomic & Molecular Physics	5	1	0	25	75	100	6	DEC
DECP-502A	Experimental Techniques	4	0	0	25	75	100	4	DEC
DECP-503A	Linear Algebra & Tensor Analysis	5	1	0	25	75	100	6	DEC
DECP-504A	Experimental Techniques Lab	0	0	4	15	35	50	2	DEC
DECP-505A	Biological & Medical Physics	5	1	0	25	75	100	6	DEC
DECP-506A	Astronomy & Astrophysics	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**	

JC BOSE UNIVERSITY OF SCIENCE AND TECHNOLOGY, YMCA, FARIDABAD

DEPARTMENT OF PHYSICS

SCHEME B.SC. (H) PHYSICS

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-601A	Electromagnetic Theory	4	0	0	25	75	100	4	DCC
BPH-602A	Statistical Mechanics	4	0	0	25	75	100	4	DCC
BPH-603A	Electromagnetic Theory Lab	0	0	4	15	35	50	2	DCC
BPH-604A	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-601A	Nuclear & Particle Physics	5	1	0	25	75	100	6	DEC
DECP-602A	Nano Materials & Applications	4	0	0	25	75	100	4	DEC
DECP-603A	Physics of Devices & Communication	4	0	0	25	75	100	6	DEC
DECP-604A	Nano Materials & Applications Lab	0	0	4	15	35	50	2	DEC
DECP-605A	Physics of Devices & Communication Lab	0	0	4	15	35	50	2	DEC
DECP-606A	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 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 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 the 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 mark sheet in the examination branch by forwarding his/her application through the course coordinator and chairperson.

Syllabus of B.Sc. (H) Physics

Semester I

Discipline Core Course (DCC)

B.Sc. (H) PHYSICS SEMESTER I
CODE: BPH-101A
SUBJECT NAME: MATHEMATICAL PHYSICS-I
NO. OF CREDITS: 4

L	T	P		
			SESSIONAL	: 25
			FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-A is compulsory and contains 10 questions each of 1.5 marks covering the entire syllabus. Part-B has 6 questions each of 15 marks and students are required to attempt any four questions from this part.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

BPH101A.1 *Revise the knowledge of calculus, vectors and vector calculus.*

BPH101A.2 *Solve problems based on calculus, vectors and vector calculus.*

BPH101A.3 *Use of fundamentals of calculus, vectors and vector calculus for various problems in physics.*

BPH101A.4 *Learn the curvilinear coordinates which have applications in problems with spherical and cylindrical symmetries.*

BPH101A.5 *Understand the Dirac delta function and its properties.*

BPH101A.6 *Analyze the transformation equations relating cartesian, spherical and cylindrical coordinate systems.*

UNIT-I

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

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. (12 Lectures)

UNIT-II

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.

Vector Calculus: Vector Differentiation: Directional derivatives and normal derivatives. Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field. Del and Laplacian operators. Vector identities. (12 Lectures)

UNIT-III

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's divergence theorem, Green's and Stokes Theorems, and their verification (no rigorous proofs). (12 Lectures)

UNIT-IV

Orthogonal Curvilinear Coordinates: Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems.

Dirac Delta function: Definition of Dirac delta function and simple examples. (12 Lectures)

Reference Books:

1. Mathematical Methods for Physicists, G.B.Arfken, H.J.Weber, F.E.Harris, 1513, 7th Edn., Elsevier.
2. An introduction to ordinary differential equations, E.A. Coddington, 1509, PHI learning
3. Differential Equations, George F. Simmons, 1507, McGraw Hill.
4. Advanced Engineering Mathematics, D.G. Zill and W.S.Wright, 5 Ed., 1512, Jones and Bartlett Learning
5. Mathematical Physics, Goswami, 1st edition, Cengage Learning
6. Engineering Mathematics, S.Pal and S.C. Bhunia, 1515, Oxford University Press
7. Advanced Engineering Mathematics, Erwin Kreyszig, 1508, Wiley India.

SUGGESTED WEB SOURCES:

1. NPTEL :: Courses
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for BPH-101A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
BPH101A.1	3	-	2	2	2	3	-	1	1	-	-	-	-	-	-	3	2	1
BPH101A.2	3	-	3	3	3	3	-	2	1	-	2	-	-	-	-	3	3	2
BPH101A.3	3	1	3	3	3	3	1	3	1	2	2	-	2	-	1	3	3	2
BPH101A.4	3	-	2	2	2	3	-	1	1	-	1	-	-	-	-	3	2	1
BPH101A.5	3	-	2	2	2	3	-	2	1	-	1	-	-	-	-	3	3	1
BPH101A.6	3	1	3	3	3	3	2	3	1	2	2	-	2	-	1	3	3	2

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER I
CODE: BPH-102A
SUBJECT NAME: MECHANICS
NO. OF CREDITS: 4

L	T	P		
			SESSIONAL	: 25
			FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-A is compulsory and contains 10 questions each of 1.5 marks covering the entire syllabus. Part-B has 6 questions each of 15 marks and students are required to attempt any four questions from this part.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

BPH102A.1	*Explain the fundamental concepts of mechanics involving laws of motion and their application to various dynamical situations, notion of inertial frames and concept of Galilean invariance.*
BPH102A.2	*Acquire thorough understanding of work and energy concepts in various mechanical systems.*
BPH102A.3	*Understand the analogy and differences between translational and rotational dynamics, and application of both motions.*
BPH102A.4	*Describe the principles of elasticity through the study of various elastic constants.*
BPH102A.5	*Apply Kepler's law to describe the motion of planets and satellites in circular orbit, through the study of the law of Gravitation.*
BPH102A.6	Illustrate the special theory of relativity and its effects on mass and energy of a moving object.

Unit-I

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 a uniform gravitational field~~. Dynamics of a system of particles. Centre of Mass. Principle of conservation of momentum. Impulse.

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. (12 Lectures)

Unit-II

Collisions: Elastic and inelastic collisions between particles. Centre of Mass and Laboratory frames.

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.

Elasticity: Review of relation between Elastic constants. Twisting torque on a Cylinder or Wire (only qualitative discussion). (12 Lectures)

Unit-III

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

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).

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.~~ (12 Lectures)

Unit-IV

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.

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~~. (12 Lectures)

Reference Books:

1. Introduction to Classical Mechanics, R. G. Takwale, P. S. Puranik, Tata McGraw-Hill.
2. An introduction to Mechanics, D. Kleppner, R.J. Kolenkow, McGraw-Hill.

3. Mechanics, Berkeley Physics, vol.1, C. Kittel, W. Knight, et.al., Tata McGraw-Hill.
4. Fundamentals of Physics, R. Resnick, D. Halliday and J. Walker, Wiley Publications.
5. Feynman Lecture Series, Vol.I, R.P.Feynman, R.B.Leighton, M.Sands, Pearson Education
6. Mechanics, D.S. Mathur, S.Chand and Company Limited.
7. Theoretical Mechanics, M.R. Spiegel, 1506, Tata McGraw Hill.

SUGGESTED WEB SOURCES:

1. NPTEL :: Courses
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for BPH-102A

Course Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PO13**	**PO14**	**PO15**	**PSO1**	**PSO2**	**PSO3**
BPH102A.1	3	3	3	3	3	2	2	3	3	3	2	-	3	2	3	3	3	2
BPH102A.2	3	3	3	3	3	2	3	3	3	3	3	-	2	3	3	3	3	3
BPH102A.3	3	3	3	3	2	2	2	3	3	3	3	-	1	2	3	3	3	3
BPH102A.4	3	3	2	3	3	2	3	3	3	2	2	-	2	1	3	3	3	3
BPH102A.5	3	3	3	3	2	1	3	3	3	2	2	-	2	2	3	3	3	3
BPH102A.6	3	3	3	3	3	2	3	3	3	2	2	-	2	1	3	3	3	2

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER I
CODE: BPH-103A
SUBJECT NAME: MATHEMATICAL PHYSICS –I LAB
NO. OF CREDITS: 2

				SESSIONAL	: 15
L	T	P		FINAL EXAM	: 35
0	0	4		TOTAL	: 50

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

BPH103A.1 *Learn the basics of C/C++ programming language.*
BPH103A.2 *Learn conditional and unconditional loops and portray their use in various physics problems.*
BPH103A.3 *Understand the programming of numerical algebraic methods considering simple physics equations, in C++ programming language.*
BPH103A.4 *Solving simple problems with numerical differentiation and integration using C++ programming language.*
BPH103A.5 *Learn the generation of random numbers in C++ programming language.*
BPH103A.6 *Understand the evaluation and plotting of trigonometric functions like sinθ, cosθ and tanθ using programming language.*
BPH103A.7 *Determine computationally the area of BH Hysteresis loop*.
BPH103A.8 *Compute current values in RC, LC with DC source and analyze radioactive decay computationally*.

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 a circle, area of a square, the volume of a 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*, *cos*, *tan* 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 the 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 $0 \le t \le 15$.

Referred Books:

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

SUGGESTED WEB SOURCES:

1. Virtual Labs (vlab.co.in)

MODE OF TRANSACTION: Demonstration, E-tutoring, discussion; **LMS/ICT Tools:** Online Resources.

Mapping of CO and PO for BPH-103A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
BPH103A.1	3	1	2	2	3	3	3	1	1	3	2	-	2	2	2	3	3	2
BPH103A.2	3	1	2	2	3	3	3	2	1	3	2	-	2	2	2	3	3	2
BPH103A.3	3	1	2	2	3	3	3	2	1	3	2	-	2	2	2	3	3	2
BPH103A.4	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	3
BPH103A.5	3	1	2	2	3	3	3	2	1	3	2	-	2	2	2	3	3	2
BPH103A.6	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	3
BPH103A.7	3	2	2	3	3	3	3	3	1	3	2	-	2	2	2	3	3	3
BPH103A.8	3	2	2	3	3	3	3	3	1	3	2	-	2	2	2	3	3	3

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER I
CODE: BPH-104A
SUBJECT NAME: MECHANICS LAB
NO. OF CREDITS: 2

			SESSIONAL	: 15
L	T	P	FINAL EXAM	: 35
0	0	4	TOTAL	: 50

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

BPH104A.1	*Precisely measure the various physical parameters involved in mechanics and be able to compute random errors in these.*
BPH104A.2	*Compute Height, width and area of a window/Building using sextant.*
BPH104A.3	*Determination of spring constant by examining the motion of a spring*
BPH104A.4	*Estimate the moment of inertia of a flywheel.*
BPH104A.5	*Compute the value of acceleration due to gravity and velocity for a freely falling body using digital timing technique.*
BPH104A.6	*Estimate Young's modulus of a wire by optical lever method.*
BPH104A.7	*Determine the modulus of rigidity of a wire by Maxwell's needle method.*
BPH104A.8	*Calculate the value of acceleration due to gravity using Bar pendulum and Kater's Pendulum.*

Select at least 06 experiments from the following

1. Measurements of length (or diameter) using vernier caliper, screw gauge and travelling microscope.
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

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

SUGGESTED WEB SOURCES:

1. Virtual Labs (vlab.co.in)

MODE OF TRANSACTION: Demonstration, E-tutoring, discussion; **LMS/ICT Tools:** Online Resources.

Mapping of CO and PO for BPH-104A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
BPH104A.1	3	3	3	3	3	2	3	3	3	2	2	-	3	1	3	3	3	3
BPH104A.2	3	3	3	3	3	2	3	3	2	2	2	-	2	2	3	3	3	3
BPH104A.3	3	3	3	3	3	2	3	3	2	3	1	-	2	2	3	3	3	3
BPH104A.4	3	3	3	3	3	2	3	3	3	2	1	-	2	2	3	3	2	3
BPH104A.5	3	3	3	3	3	2	3	3	2	3	1	-	2	1	3	3	3	3
BPH104A.6	3	3	3	3	3	1	3	3	3	2	2	-	1	1	3	3	2	3
BPH104A.7	3	3	3	3	3	2	3	3	2	2	1	-	2	1	3	3	3	3
BPH104A.8	3	3	3	3	3	1	3	3	3	2	1	-	2	1	3	3	3	3

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

Ability Enhancement Compulsory Course (AECC)

B.Sc. (H) PHYSICS SEMESTER I
CODE: BENG-101A
SUBJECT NAME: ENGLISH
NO. OF CREDITS: 2

			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
2	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-A is compulsory and contains 10 questions each of 1.5 marks covering the entire syllabus. Part-B has 6 questions each of 15 marks and students are required to attempt any four questions from this part.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

BENG101A.1 *Learn about communication process and ways to make communication effective by giving attention to all elements involved.*

BENG101A.2 *Understand the value of verbal communication as well as non- verbal aspects of communication in making inter personnel communication effective and intrapersonnel communication insightful.*

BENG101A.3 *Gain confidence by enhancing their abilities to articulate their ideas.*

BENG101A.4 *Able to scan, skim and revise documents for fruitful reading and comprehension.*

BENG101A.5 *Acquire better writing skills in formal communication.*

BENG101A.6 *Able to comprehend, analyze and interpret information for effective communication.*

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. Writing Skills Documenting Report Writing Making notes Letter writing.

Reference Books:

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

SUGGESTED WEB SOURCES:

1. NPTEL :: Courses
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for BENG-101A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
BENG101A.1	-	3	3	2	2	2	2	-	-	-	2	2	1	1	3	-	-	-
BENG101A.2	-	3	3	2	2	2	2	-	-	-	2	2	1	1	3	-	-	-
BENG101A.3	-	3	3	2	2	2	2	-	2	-	2	2	1	2	3	-	-	-
BENG101A.4	2	3	3	3	3	3	3	-	2	2	2	3	2	2	3	-	-	-
BENG101A.5	2	3	3	3	3	3	3	-	2	2	2	3	2	2	3	-	-	-
BENG101A.6	-	3	3	2	2	2	2	-	-	2	2	3	2	2	3	-	-	-

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

Open Elective Courses (OEC)

B.Sc. (H) PHYSICS SEMESTER I
CODE: OMTH-101A
SUBJECT NAME: CALCULUS
NO. OF CREDITS: 6

L	T	P		
			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
5	1	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-A is compulsory and contains 10 questions each of 1.5 marks covering the entire syllabus. Part-B has 6 questions each of 15 marks and students are required to attempt any four questions from this part.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

OMTH101A.1 *Acquire knowledge about differential calculus.*

OMTH101A.2 *Learn about partial differentiation and maxima-minima of functions of two variables.*

OMTH101A.3 *Understand about integral calculus: single integral and double integral.*

OMTH101A.4 *Solve problems on triple integral and beta and gamma functions.*

OMTH101A.5 *Apply the knowledge of integral calculus to compute the enclosed area under plane curves and volume in solids of revolution.*

OMTH101A.6 *Explore the curvature of curves by determining radius of curvature and centre of curvature.*

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), Centre of curvature.

(15 Lectures)

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). (15 Lectures)

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. (15 Lectures)

UNIT IV

Triple Integral, curvilinear coordinates, Change of variables,Volume of solids, Beta & Gamma functions and relation between them. (15 Lectures)

Reference Books:

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

SUGGESTED WEB SOURCES:

1. NPTEL :: Courses
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for OMTH-101A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
OMTH101A.1	3	-	2	2	2	3	-	1	-	-	-	-	-	-	-	2	1	-
OMTH101A.2	3	-	2	2	2	3	-	2	-	-	1	-	-	-	-	2	2	-
OMTH101A.3	3	-	3	3	3	3	-	3	-	2	2	-	-	-	-	2	2	-
OMTH101A.4	3	1	3	3	3	3	1	3	1	2	2	-	2	1	1	2	3	-
OMTH101A.5	3	2	3	3	3	3	2	3	1	2	2	-	2	2	1	2	3	-
OMTH101A.6	3	2	3	3	3	3	2	3	1	2	2	-	2	2	1	2	3	-

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER I
CODE: OCSE-101A
SUBJECT NAME: INTRODUCTION TO PROGRAMMING
NO. OF CREDITS: 4

L	T	P		
			SESSIONAL	: 25
			FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-A is compulsory and contains 10 questions each of 1.5 marks covering the entire syllabus. Part-B has 6 questions each of 15 marks and students are required to attempt any four questions from this part.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

OCSE101A.1 Understand the syntax of the C^{++} language.

OCSE101A.2 Differentiate between Procedure-Oriented programming and Object-Oriented programming.

OCSE101A.3 Understand and apply various object oriented features.

OCSE101A.4 Explore the conditional and iterative statements in C^{++} language.

OCSE101A.5 Solve various computing problems using C^{++} language.

OCSE101A.6 Apply object oriented concepts in real world programs.

UNIT-I
Introduction to C and C^{++}: 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:
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). (10 Lectures)

UNIT-II

Expressions, Conditional Statements and Iterative Statements

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

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. 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 Multidimensional arrays. (18 Lectures)

UNIT-III

Derived Data Types (Structures and Unions)

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

Opening and closing a file, 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~~ (10 Lectures)

UNIT-IV

Using Classes in C++:

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

Inheritance and Polymorphism: Introduction to Inheritance and Polymorphism.

(14 Lectures)

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.

SUGGESTED WEB SOURCES:

1. NPTEL :: Courses
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for OCSE-101A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
OCSE101A.1	3	1	3	2	2	3	1	2	-	3	1	-	-	1	2	2	1	-
OCSE101A.2	3	2	3	3	3	3	2	3	-	3	2	-	2	2	2	2	2	-
OCSE101A.3	3	1	3	2	2	3	1	2	-	3	1	-	-	1	2	2	1	-
OCSE101A.4	3	2	2	3	3	3	2	3	-	3	2	-	2	2	2	2	2	-
OCSE101A.5	3	2	2	3	3	3	2	2	-	3	2	2	2	2	2	2	2	-
OCSE101A.6	3	2	2	3	3	3	2	2	-	3	2	2	2	2	2	2	2	-

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER I
CODE: OCSE-102A
SUBJECT NAME: INTRODUCTION TO PROGRAMMING LAB
NO. OF CREDITS: 2

L	T	P		
			SESSIONAL	: 15
			FINAL EXAM	: 35
0	0	4	TOTAL	: 50

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

OCSE102A.1 Understand the basic algebraic operations in C^{++} language.

OCSE102A.2 Learn find and print commands in C^{++} language.

OCSE102A.3 Program the automatic computation of grades of students for given set of their marks.

OCSE102A.4 Understand iterative statements by printing natural numbers, odd or even numbers in C^{++} language.

OCSE102A.5 Analyze conditional statements by computing greatest of three numbers in C^{++} language.

OCSE102A.6 Determine computationally gross salary of a person.

OCSE102A.7 Perform matrix algebraic operations in C^{++} language.

OCSE102A.8 Apply object oriented concepts in real mathematical programs.

Introduction to Programming Lab

1. Write a program to print “HELLO”
2. Write a program to add two numbers.
3. Write a program to calculate simple interest.
4. Write a program to calculate absolute value of a number.
5. Write a program to swap the values of two numbers.
6. Write a program to find gross salary of a person.
7. Write a program to check if a number is even or odd.
8. Write a program to find greatest of three numbers.
9. Write a program to find grade of a student given his marks.
10. Write a program to find divisor or factorial of a given number.
11. Write a program to print the Fibonacci series.
12. Write a program to print first ten natural numbers.
13. Write a program to print the reverse of a number.
14. Write a program to print the multiplication table of a given number.

15. Write a program to find grade of a list of students given their marks.
16. Write a program using function power (a, b) to calculate the value of a raised to b.
17. Write a program to print a 1-D array of 10 numbers in reverse order.
18. 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
19. Write a program to calculate the length of a string.
20. Write a program to copy the contents of one file into another.

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", 8th Edition, Prentice Hall, 2011.
4. John R. Hubbard, "Programming with C++", Schaum's Series, 2nd Edition, 2000.

SUGGESTED WEB SOURCES:

1. Virtual Labs (vlab.co.in)

MODE OF TRANSACTION: Demonstration, E-tutoring, discussion; **LMS/ICT Tools:** Online Resources.

Mapping of CO and PO for OCSE-102A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
OCSE102A.1	3	1	3	2	2	3	2	2	-	3	1	1	-	1	2	2	1	-
OCSE102A.2	3	1	3	2	2	3	2	2	-	3	1	1	-	1	2	2	2	-
OCSE102A.3	3	2	2	3	3	3	2	2	-	3	2	2	2	2	2	2	2	-
OCSE102A.4	3	1	3	2	2	3	2	2	-	3	1	1	-	1	2	2	2	-
OCSE102A.5	3	2	2	3	3	3	2	2	-	3	2	2	2	2	2	2	2	-
OCSE102A.6	3	2	2	3	3	3	2	2	-	3	2	2	2	2	2	2	2	-
OCSE102A.7	3	2	2	3	3	3	2	2	-	3	2	2	2	2	2	2	2	-
OCSE102A.8	3	2	2	3	3	3	2	2	-	3	2	2	2	2	2	2	2	-

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER I
CODE: OELC-101A
SUBJECT NAME: ELECTRONIC CIRCUITS AND PCB DESIGNING
NO. OF CREDITS: 4

L	T	P		
			SESSIONAL	: 25
4	0	0	FINAL EXAM	: 75
			TOTAL	: 100

NOTE: Question paper will have two parts. Part-A is compulsory and contains 10 questions each of 1.5 marks covering the entire syllabus. Part-B has 6 questions each of 15 marks and students are required to attempt any four questions from this part.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

OELC101A.1 Acquire knowledge about network theorems.

OELC101A.2 Learn about semiconductor diode and its applications.

OELC101A.3 Know the working of BJT and Small Signal amplifier.

OELC101A.4 Understand the fabrication and circuit designing on PCB.

OELC101A.5 Investigate the voltage regulation using zener diode.

OELC101A.6 Explore the principles of laminates, photo-printing, etching and soldering.

Unit-I

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.
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. (14 Lectures)

Unit-II

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. (12 Lectures)

Unit-III

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. (12 Lectures)

UNIT-IV

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. (10 Lectures)

Reference 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.

SUGGESTED WEB SOURCES:

1. NPTEL :: Courses
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for OELC-101A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
OELC101A.1	3	-	2	2	2	3	-	1	-	-	-	-	-	-	-	3	3	-
OELC101A.2	3	-	3	3	3	3	1	3	1	2	2	-	-	-	1	3	3	-
OELC101A.3	3	-	2	2	2	3	-	2	-	-	1	-	-	-	-	3	3	-
OELC101A.4	3	1	3	3	3	3	1	3	1	2	2	-	2	1	1	3	3	-
OELC101A.5	3	2	3	3	3	3	2	3	1	2	2	-	2	2	1	3	3	-
OELC101A.6	3	2	3	3	3	3	2	3	1	2	2	-	2	2	1	3	3	-

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER I
CODE: OELC-102A
SUBJECT NAME: ELECTRONIC CIRCUITS AND PCB DESIGNING LAB
NO. OF CREDITS: 2

L	T	P		
			SESSIONAL	: 15
			FINAL EXAM	: 35
0	0	4	TOTAL	: 50

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

OELC102A.1 Analyze the Thevenin's, superposition and maximum power transfer theorems.

OELC102A.2 Understand the voltage regulation using zener diode.

OELC102A.3 Learn and predict the characteristics of common emitter transistor.

OELC102A.4 Design the various basic electronic circuits for a given output.

OELC102A.5 Understand the basics of half wave and full wave rectifier.

OELC102A.6 Examine the performance of some basic electronic circuits.

OELC102A.7 Test of a power supply with zener regulator.

OELC102A.8 Design and study voltage divider biasing.

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

Reference 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.

SUGGESTED WEB SOURCES:

1. [Virtual Labs (vlab.co.in)]

MODE OF TRANSACTION: Demonstration, E-tutoring, discussion; **LMS/ICT Tools:** Online Resources.

Mapping of CO and PO for OELC-102A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
OELC102A.1	3	2	3	3	3	3	3	2	1	3	3	-	3	3	2	3	3	3
OELC102A.2	3	1	2	2	3	3	3	1	1	2	2	-	2	2	2	3	3	2
OELC102A.3	3	1	2	2	3	3	3	2	1	2	2	-	2	2	2	3	3	2
OELC102A.4	3	2	3	3	3	3	3	3	1	3	3	-	3	3	2	3	3	3
OELC102A.5	3	1	2	2	3	3	3	2	1	2	2	-	2	2	2	3	3	2
OELC102A.6	3	2	3	3	3	3	3	3	2	2	3	-	3	3	2	3	3	3
OELC102A.7	3	2	3	3	3	3	3	3	1	3	3	-	3	3	2	3	3	3
OELC102A.8	3	2	3	3	3	3	3	3	1	3	3	-	3	3	2	3	3	3

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER I
CODE: OCHE-101A
SUBJECT NAME: INORGANIC CHEMISTRY
NO. OF CREDITS: 4

L	T	P		
			SESSIONAL	: 25
			FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-A is compulsory and contains 10 questions each of 1.5 marks covering the entire syllabus. Part-B has 6 questions each of 15 marks and students are required to attempt any four questions from this part.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

OCHE101A.1 *Solve the conceptual questions based on the quantum mechanical model of the atom.*

OCHE101A.2 *Draw the plausible structures and geometries of molecules using Radius Ratio Rules, VSEPR theory and MO diagrams (homo- & hetero-nuclear diatomic molecules).*

OCHE101A.3 *Understand the concept of lattice energy using Born-Landé equation.*

OCHE101A.4 *Understanding of the bonding models, structures, reactivity's, and applications of coordination complexes, metal carbonyls, and organometallics.*

OCHE101A.5 *Diagrammatically explain the working of the sodium-potassium pump in organisms and the factors affecting*

OCHE101A.6 *Explain the applications of iron in biological systems with particular reference to haemoglobin, myoglobin, ferritin and transferrin*

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 *ml* and *ms*. Shapes of *s*, *p* and *d* atomic orbitals, nodal planes. Discovery of spin, spin quantum number (*s*) and magnetic spin quantum number(*ms*).

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. (14 Lectures)

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^+.

(14 Lectures)

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 IR frequencies). (10 Lectures)

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. (10 Lectures)

Reference Books:

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

SUGGESTED WEB SOURCES:

1. NPTEL :: Courses
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for OCHE-101A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
OCHE101A.1	3	2	3	3	3	3	2	3	1	2	2	-	2	2	1	2	2	-
OCHE101A.2	3	1	3	3	3	3	1	3	1	2	2	-	2	2	1	2	2	-
OCHE101A.3	3	-	2	3	3	3	-	3	-	-	1	-	-	-	-	2	1	-
OCHE101A.4	3	-	2	3	3	3	-	3	-	-	1	-	-	-	-	2	1	-
OCHE101A.5	3	1	3	3	3	3	1	3	1	2	2	-	2	2	1	2	2	-
OCHE101A.6	3	2	3	3	3	3	2	3	1	2	2	-	2	2	1	2	2	-

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER I
CODE: OCHE-102A
SUBJECT NAME: INORGANIC CHEMISTRY LAB
NO. OF CREDITS: 2

L	T	P		
			SESSIONAL	: 15
			FINAL EXAM	: 35
0	0	4	TOTAL	: 50

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

OCHE102A.1 *Learn the basics of preparation of inorganic complexes.*

OCHE102A.2 *Understand the method of volumetric analysis.*

OCHE102A.3 *Use of redox, iodometric and complexometric titrations.*

OCHE102A.4 *Analyze the inorganic compounds using colorimetry..*

OCHE102A.5 *Verify Beer - Lambert law for KMnO4 /K2Cr2O7 and determine the concentration of the given KMnO4 /K2Cr2O7 solution.*

OCHE102A.6 *Understand principles involved in chromatographic separations.*

OCHE102A.7 *Investigate following metal ions using paper chromatographic separation: i. Ni (II) and Co (II) ii. Cu(II) and Cd(II).*

OCHE102A.8 *Explore the role of ligands in inorganic chemistry.*

The students have to perform at least 6 experiments from the following

1. Preparations: (Any three)
   Preparation of Cuprous chloride, tetra ammine cupric sulphate, chrome alum, potassium trioxalatochromate(III), Nickel Dimethylglyoxime

2. Volumetric Analysis
   - Preparation of reference solutions.
   - Redox titrations: Determination of Fe2+ , C2O4 2- (using KMnO4 , K2Cr2O7)
   - Iodometric titrations: Determination of Cu2+ (using standard hypo solution).
   - Complexometric titrations: Determination of Mg2+ , Zn2+ by EDTA.

3. Colorimetry
   To verify Beer - Lambert law for KMnO4 /K2Cr 2O7 and determine the concentration of the given KMnO4 /K2Cr 2O7 solution.

4. Principles involved in chromatographic separations. Paper chromatographic separation of following metal ions: i. Ni (II) and Co (II) ii. Cu(II) and Cd(II)

Reference Books:

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

SUGGESTED WEB SOURCES:

1. Virtual Labs (vlab.co.in)

MODE OF TRANSACTION: Demonstration, E-tutoring, discussion; **LMS/ICT Tools:** Online Resources.

Mapping of CO and PO for OCHE-102A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
OCHE102A.1	3	1	1	3	2	3	1	3	-	-	1	1	1	1	1	2	1	1
OCHE102A.2	3	2	2	3	3	3	1	3	-	-	2	1	1	1	1	2	1	1
OCHE102A.3	3	2	3	3	3	3	2	3	1	-	2	2	2	2	2	2	2	2
OCHE102A.4	3	2	3	3	3	3	2	3	1	-	2	2	2	2	2	2	2	2
OCHE102A.5	3	2	3	3	3	3	2	3	1	-	2	2	2	2	2	2	2	2
OCHE102A.6	3	2	2	3	3	3	1	3	-	-	2	1	1	1	1	2	1	1
OCHE102A.7	3	2	3	3	3	3	2	3	1	-	2	2	2	2	2	2	2	2
OCHE102A.8	3	2	3	3	3	3	2	3	1	-	2	2	2	2	2	2	2	2

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

Syllabus of B.Sc. (H) Physics

Semester II

Discipline Core Course (DCC)

B.Sc. (H) PHYSICS SEMESTER II
CODE: BPH-201A
SUBJECT NAME: ELECTRICITY AND MAGNETISM
NO. OF CREDITS: 4

L	T	P		
			SESSIONAL	: 25
			FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-A is compulsory and contains 10 questions each of 1.5 marks covering the entire syllabus. Part-B has 6 questions each of 15 marks and students are required to attempt any four questions from this part.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

BPH201A.1 *Understand the concepts of electrical circuits and network theorems.*

BPH201A.2 *Solve the problems in direct current circuits using the basics of network theorems.*

BPH201A.3 *Learn the concepts of electrostatics and magnetostatics.*

BPH201A.4 *Analyze the problems of electrostatics and magnetostatics in matter.*

BPH201A.5 *Expertise the behaviour of dielectrics and magnetic materials in the presence of external electric fields and magnetic fields respectively.*

BPH201A.6 *Understand the concept of electromagnetic induction.*

Unit-I

Electrical Circuits and Network Theorems: 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. 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. (12 Lectures)

Unit-II
Electrostatics:

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.

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.~~ (12 Lectures)

Unit-III

Magnetostatics:

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. Energy stored in a Magnetic Field.

Magnetization vector (**M**). Magnetic Intensity(**H**). Magnetic Susceptibility and permeability. Relation between **B, H, M**. Diamagnetism, Paramagnetism and Ferromagnetism. B-H curve and hysteresis. Curie Temperature. (12 Lectures)

Unit-IV

Dielectric Properties: Electric Field in matter. Polarization, 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.

Electromagnetic Induction: Faraday's Law. Lenz's Law. Self Inductance and Mutual Inductance. Reciprocity Theorem. Energy stored in a ~~Magnetic Field~~ an Electromagnetic wave. Introduction to Maxwell's Equations. Charge Conservation and Displacement current. (12 Lectures)

Reference Books:

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

5. Electricity and Magnetism, J.H.Fewkes & J.Yarwood. Vol.I, 1991, Oxford Univ. Press.

SUGGESTED WEB SOURCES:

1. NPTEL :: Courses
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for BPH-201A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
BPH201A.1	3	3	3	3	3	3	2	3	2	2	2	-	3	-	2	2	2	2
BPH201A.2	3	3	3	3	3	2	2	3	2	3	3	-	2	-	2	2	2	3
BPH201A.3	3	3	3	3	3	3	2	3	2	3	2	-	3	-	2	2	3	2
BPH201A.4	3	3	3	3	3	2	3	3	2	2	2	-	2	-	2	2	3	2
BPH201A.5	3	3	3	3	3	3	2	3	2	2	2	-	2	-	2	3	2	2
BPH201A.6	3	3	3	3	3	2	2	3	2	2	2	-	2	-	2	2	3	2

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER II
CODE: BPH-202A
SUBJECT NAME: WAVES & OPTICS
NO. OF CREDITS: 4

L	T	P		
			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-A is compulsory and contains 10 questions each of 1.5 marks covering the entire syllabus. Part-B has 6 questions each of 15 marks and students are required to attempt any four questions from this part.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

BPH202A.1 *Understand the Longitudinal and Transverse Waves.*

BPH202A.2 *Learn the superposition of Two Harmonic Waves.*

BPH202A.3 *Analyze interference phenomena in various systems.*

BPH202A.4 *Find out the wavelength of light.*

BPH202A.5 *Know the phenomenon of Diffraction of light in various systems.*

BPH202A.6 *Understand the phenomena of polarization along with its applications.*

Unit-I

Wave Motion: Plane and Spherical Waves. Longitudinal and Transverse Waves. Plane Progressive (Travelling) Waves. Wave Equation. Particle and Wave Velocities. Superposition of Two Harmonic Waves**,** Phase and Group Velocities. (10 Lectures)

Unit-II

Interference: Definition and properties of wave front. Huygens Principle. Temporal and Spatial Coherence. Division of amplitude and wavefront. Young's double slit experiment. Interference in Thin Films: parallel and wedge-shaped films. Newton's Rings: Measurement of wavelength and refractive index. Interferometer: Michelson Interferometer-(1) Idea of form of fringes (No theory required), (2) Determination of Wavelength, (3) Refractive Index, and (4) Visibility of Fringes. (14 Lectures)

Unit-III

Diffraction: Fraunhofer diffraction: Single slit. Resolving Power of a telescope. Double slit. Multiple slits. Diffraction grating. Resolving power and Dispersive power of grating. Difference between dispersive power and resolving power of diffraction grating. Fresnel Diffraction: Fresnel's Assumptions. Fresnel's Half-Period Zones for Plane Wave. Theory of a Zone Plate: Multiple Foci of a Zone Plate. (12 Lectures)

Unit-IV

Polarization: Unpolarized and Polarized Light. Types of Polarization. Production of Plane Polarized Light. Polarizer and Analyzer. Malus' Law. Double Refraction in Calcite Crystal. Nicol Prism. Elliptically and Circularly Polarized Light. Analysis of Polarized Light. Applications of Polarized Light. (12 Lectures)

Reference Books

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

SUGGESTED WEB SOURCES:

1. NPTEL :: Courses
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for BPH-202A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
BPH202A.1	3	-	2	3	2	2	1	3	2	2	2	-	2	-	2	3	3	2
BPH202A.2	3	-	2	2	2	2	-	3	2	2	2	-	2	-	2	3	3	3
BPH202A.3	3	1	3	3	3	3	2	3	3	3	3	-	3	-	3	3	3	3
BPH202A.4	3	-	2	2	2	3	-	3	2	2	3	-	2	-	3	3	3	2
BPH202A.5	3	-	2	2	2	3	-	3	3	2	3	-	2	-	3	3	3	3
BPH202A.6	3	-	2	3	2	3	2	3	3	2	3	-	2	-	3	3	3	3

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER II
CODE: BPH-203A
SUBJECT NAME: ELECTRICITY AND MAGNETISM LAB
NO. OF CREDITS: 2

			SESSIONAL	: 15
L	T	P	FINAL EXAM	: 35
0	0	4	TOTAL	: 50

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

BPH203A.1 *Learn the basics and verify experimentally the network theorems.*

BPH203A.2 *Determine unknown resistance value using various methods.*

BPH203A.3 *Measure the magnetic field and its variation for a solenoid.*

BPH203A.4 *Study and analyze response curves of series and parallel LCR circuits.*

BPH203A.5 *Examine high resistance, charge and current sensitivity values of Ballistic Galvanometer.*

BPH203A.6 *Analyze the characteristics of RC circuits.*

BPH203A.7 *Determine self inductance and mutual inductance values.*

BPH203A.8 *Compare capacitances using De'Sauty's bridge.*

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

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

SUGGESTED WEB SOURCES:

1. Virtual Labs (vlab.co.in)

MODE OF TRANSACTION: Demonstration, E-tutoring, discussion; **LMS/ICT Tools:** Online Resources.

Mapping of CO and PO for BPH-203A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
BPH203A.1	3	3	3	3	3	3	2	3	2	2	2	-	3	-	2	2	2	2
BPH203A.2	3	3	3	3	3	3	2	3	2	3	3	-	2	-	2	2	3	3
BPH203A.3	3	3	3	3	3	3	2	3	2	3	2	-	3	-	2	2	2	2
BPH203A.4	3	3	3	3	3	3	3	3	2	2	2	-	2	-	2	3	3	3
BPH203A.5	3	3	3	3	3	3	3	3	2	2	2	-	2	-	3	2	2	2
BPH203A.6	3	3	3	3	3	3	2	3	2	2	2	-	2	-	2	2	3	2
BPH203A.7	3	3	3	3	3	3	2	3	2	2	2	-	2	-	2	2	3	2
BPH203A.8	3	3	3	3	3	3	2	3	2	2	2	-	2	-	2	2	3	2

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER II
CODE: BPH-204A
SUBJECT NAME: WAVES & OPTICS LAB
NO. OF CREDITS: 2

L	T	P		
			SESSIONAL	: 15
			FINAL EXAM	: 35
0	0	4	TOTAL	: 50

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

BPH204A.1 *Understand the basic concepts of optics.*

BPH204A.2 *Determine the optical parameters and properties like refractive index, resolving power and dispersive power etc.*

BPH204A.3 *Examine the principles of prediction of wavelength of unknown radiation by determining the wavelength of sodium light.*

BPH204A.4 *Investigate the motion of coupled oscillators.*

BPH204A.5 *Determine the thickness of a thin paper using optical methods.*

BPH204A.6 *Analyze the phenomenon of Diffraction of light in various systems.*

BPH204A.7 *Verify λ^2 –T law for an electric tuning fork by Melde's experiment.*

BPH204A.8 *Determine angle of prism using Schuster`s focusing.*

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 the 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

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

SUGGESTED WEB SOURCES:

1. Virtual Labs (vlab.co.in)

MODE OF TRANSACTION: Demonstration, E-tutoring, discussion; **LMS/ICT Tools:** Online Resources.

Mapping of CO and PO for BPH-204A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
BPH204A.1	3	2	3	3	3	3	2	3	2	2	2	2	2	1	2	3	3	2
BPH204A.2	3	2	3	3	3	3	3	3	2	2	2	2	3	2	2	3	3	3
BPH204A.3	3	2	3	3	3	3	3	3	2	2	2	2	3	2	2	3	3	3
BPH204A.4	3	2	3	3	3	3	3	3	2	2	2	2	3	2	2	3	3	3
BPH204A.5	3	2	3	3	3	3	3	3	2	2	2	2	3	2	2	3	3	3
BPH204A.6	3	2	3	3	3	3	3	3	2	2	2	2	3	2	2	3	3	3
BPH204A.7	3	2	3	3	3	3	3	3	2	2	2	2	3	2	2	3	3	3
BPH204A.8	3	2	3	3	3	3	3	3	2	2	2	2	3	2	2	3	3	3

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

Ability Enhancement Compulsory Course (AECC)

B.Sc. (H) PHYSICS SEMESTER II
CODE: BEVS-201A
SUBJECT NAME: ENVIRONMENTAL SCIENCE
NO. OF CREDITS: 2

L	T	P		
			SESSIONAL	: 25
			FINAL EXAM	: 75
2	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-A is compulsory and contains 10 questions each of 1.5 marks covering the entire syllabus. Part-B has 6 questions each of 15 marks and students are required to attempt any four questions from this part.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

BEVS201A.1 *Learn the basics of ecosystem, biodiversity, renewable and non-renewable resources.*

BEVS201A.2 *Analyze the environmental pollution, policies and practices.*

BEVS201A.3 *Correlate the environment with human communities.*

BEVS201A.4 *Examine the surrounding environment via field work.*

BEVS201A.5 *Apply the knowledge to safeguard the environment.*

BEVS201A.6 *Understand the important facts about the environment and aware the surrounding community of the same.*

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.

SUGGESTED WEB SOURCES:

1. NPTEL :: Courses
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for BEVS-201A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
BEVS201A.1	3	1	3	2	2	3	1	2	2	-	2	2	1	2	3	2	2	-
BE VS201A.2	3	2	3	2	3	3	2	3	3	-	3	2	1	3	3	2	2	-
BE VS201A.3	3	2	3	2	3	3	3	3	3	-	3	3	2	3	3	2	2	2
BE VS201A.4	3	2	3	2	3	3	2	3	3	-	3	3	2	3	3	2	2	2
BE VS201A.5	3	2	2	3	3	3	3	3	3	-	3	3	2	3	3	2	2	2
BE VS201A.6	3	2	3	2	3	3	3	3	3	-	3	3	2	3	3	2	2	2

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

Open Elective Courses (OEC)

B.Sc. (H) PHYSICS SEMESTER II
CODE: OMTH-201A
SUBJECT NAME: LINEAR ALGEBRA
NO. OF CREDITS: 6

L	T	P		
			SESSIONAL	: 25
			FINAL EXAM	: 75
5	1	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-A is compulsory and contains 10 questions each of 1.5 marks covering the entire syllabus. Part-B has 6 questions each of 15 marks and students are required to attempt any four questions from this part.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

OMTH201A.1 *Learn the Gauss–Jordan row reduction, Reduced row echelon form.*

OMTH201A.2 *Locate and use information to solve problems of linear transformations and vector spaces.*

OMTH201A.3 *Describe the concept of linear independence, linear transformation and determinants.*

OMTH201A.4 *Find eigen-values and eigen-vectors and diagonalization of matrices.*

OMTH201A.5 *Understand orthogonal and orthonormal bases.*

OMTH201A.6 *Solve homogenous and non-homogenous system of equations using matrices.*

UNIT-I

Fundamental operation with vectors in Euclidean space $\mathbf{R}^{\mathbf{n}}$, Linear combination of vectors, Dot product and their properties, Cauchy-Schwarz inequality, Triangle inequality, Projection of vectors, Some elementary results on vector in $\mathbf{R}^{\mathbf{n}}$, Matrices, Echelon matrices, Row canonical form , Row equivalence, Rank, Linear combination of vectors, Row space, Eigenvalues, Eigenvectors, Eigenspace, Characteristic polynomials. (15 Lectures)

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. (15 Lectures)

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.

(15 Lectures)

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. (15 Lectures)

Reference Books:

1. Schaum's Outlines, Linear Algebra, Mc Graw Hill Education.
2. S. Andrilli and D. Hecker, Elementary Linear Algebra, Academic Press, 4/e (2012)
3. B. Kolman and D.R. Hill, Introductory Linear Algebra with Applications, Pearson Education, 7/e (2003)

SUGGESTED WEB SOURCES:

1. NPTEL :: Courses
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for OMTH-201A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
OMTH201A.1	3	-	2	2	2	3	-	1	-	-	-	-	-	-	-	2	2	-
OMTH201A.2	3	2	3	3	3	3	2	3	-	2	2	-	2	2	1	2	3	-
OMTH201A.3	3	-	3	2	2	3	-	2	-	-	1	-	-	-	-	2	2	-
OMTH201A.4	3	-	3	2	2	3	-	2	-	-	1	-	-	-	-	2	3	-
OMTH201A.5	3	-	2	2	2	3	-	2	-	-	1	-	-	-	-	2	3	-
OMTH201A.6	3	-	3	3	3	3	-	3	-	2	2	-	2	-	1	2	3	-

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER II
CODE: OCSC-201A
SUBJECT NAME: INTRODUCTION TO DATABASE SYSTEM
NO. OF CREDITS: 4

L	T	P		
			SESSIONAL	: 25
4	0	0	FINAL EXAM	: 75
			TOTAL	: 100

NOTE: Question paper will have two parts. Part-A is compulsory and contains 10 questions each of 1.5 marks covering the entire syllabus. Part-B has 6 questions each of 15 marks and students are required to attempt any four questions from this part.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

OCSC201A.1 *Understand the basic concepts, applications and architecture of database systems.*

OCSC201A.2 *Master the basics of ER diagram.*

OCSC201A.3 *Understand relational database algebra expressions.*

OCSC201A.4 *Construct queries using Structured Query Language (SQL).*

OCSC201A.5 *Understand sound design principles for logical design of databases, normalization.*

OCSC201A.6 *Create relationships between and modify database tables using SQL.*

UNIT-I

Database: Introduction to database, relational data model, DBMS architecture, data independence, DBA, database users, end users, front end tools. (12 Lectures)

UNIT-II

E-R Modeling: Entity types, entity set, attribute and key, relationships, relation types, E- R diagrams, database design using ER diagrams (12 Lectures)

UNIT-III

Relational Data Model: Relational model concepts, relational constraints, primary and foreign key, normalization: 1NF, 2NF, 3NF. (12 Lectures)

UNIT-IV

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. (12 Lectures)

Reference Books:

1. Fundamentals of Database Systems by R. Elmasri and S.B. Navathe, 3rd edition, 2000, Addision-Wesley, Low Priced Edition.
2. An Introduction to Database Systems by C.J. Date, 7th edition, Addison-Wesley, Low Priced Edition, 2000.
3. Database Management and Design by G.W. Hansen and J.V. Hansen, 2nd edition, 1999, Prentice-Hall of India, Eastern Economy Edition.
4. Database Management Systems by A.K. Majumdar and P. Bhattacharyya, 5th edition, 1999, Tata McGraw-Hill Publishing.
5. A Guide to the SQL Standard, Date, C. and Darwen,H. 3rd edition, Reading, MA: 1994, Addison-Wesley.
6. Data Management & file Structure by Loomis, 1989, PHI11. P. Rob, C. Coronel, Database System Concepts by, Cengage Learning India, 2008.

SUGGESTED WEB SOURCES:

1. NPTEL :: Courses
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for OCSE-201A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
OCSE201A.1	3	1	3	2	2	3	1	2	-	3	1	-	-	1	2	2	1	-
OCSE201A.2	3	2	3	3	3	3	2	3	-	3	2	2	2	2	2	2	2	-
OCSE201A.3	3	1	3	2	2	3	1	2	-	3	1	-	-	1	2	2	1	-
OCSE201A.4	3	2	3	3	3	3	2	3	-	3	2	2	2	2	2	2	2	-
OCSE201A.5	3	2	3	3	3	3	2	3	-	3	2	2	2	2	2	2	2	-
OCSE201A.6	3	2	3	3	3	3	2	3	-	3	2	2	2	2	2	2	2	-

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER II
CODE: OCSC-202A
SUBJECT NAME: INTRODUCTION TO DATABASE SYSTEM LAB
NO. OF CREDITS: 2

L	T	P		
			SESSIONAL	: 15
			FINAL EXAM	: 35
0	0	4	TOTAL	: 50

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

OCSC202A.1 Learn the basics of database systems.

OCSC202A.2 Understand the creation of database with three tables.

OCSC202A.3 Examine the details stored in the database.

OCSC202A.4 Extract the required information from the database.

OCSC202A.5 Understand sound design principles for logical design of databases, normalization.

OCSC202A.6 Organize the information using database systems.

OCSC202A.7 Create relationships between and modify database tables.

OCSC202A.8 Explore the effective management of large set of information using database systems.

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)

Reference Books:

1. Fundamentals of Database Systems by R. Elmasri and S.B. Navathe, 3rd edition, 2000, Addision-Wesley, Low Priced Edition.
2. An Introduction to Database Systems by C.J. Date, 7th edition, Addison-Wesley, Low Priced Edition, 2000.
3. Database Management and Design by G.W. Hansen and J.V. Hansen, 2nd edition, 1999, Prentice-Hall of India, Eastern Economy Edition.
4. Database Management Systems by A.K. Majumdar and P. Bhattacharyya, 5th edition, 1999, Tata McGraw-Hill Publishing.
5. A Guide to the SQL Standard, Date, C. and Darwen,H. 3rd edition, Reading, MA: 1994, Addison-Wesley.
6. Data Management & file Structure by Loomis, 1989, PHI11. P. Rob, C. Coronel, Database System Concepts by, Cengage Learning India, 2008.

SUGGESTED WEB SOURCES:

1. Virtual Labs (vlab.co.in)

MODE OF TRANSACTION: Demonstration, E-tutoring, discussion; **LMS/ICT Tools:** Online Resources.

Mapping of CO and PO for OCSE-202A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
OCSE202A.1	3	1	3	2	2	3	2	2	-	3	1	1	-	1	2	2	1	-
OCSE202A.2	3	1	3	2	2	3	2	2	-	3	1	1	-	1	2	2	2	-
OCSE202A.3	3	2	2	3	3	3	2	2	-	3	2	2	2	2	2	2	2	-
OCSE202A.4	3	2	3	3	3	3	2	2	-	3	2	2	-	2	2	2	2	-
OCSE202A.5	3	2	3	3	3	3	2	2	-	3	2	2	2	2	2	2	2	-
OCSE202A.6	3	2	2	3	3	3	2	2	-	3	2	2	2	2	2	2	2	-
OCSE202A.7	3	2	2	3	3	3	2	2	-	3	2	2	2	2	2	2	2	-
OCSE202A.8	3	2	2	3	3	3	2	2	-	3	2	2	2	2	2	2	2	-

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER II
CODE: OELC-201A
SUBJECT NAME: INSTRUMENTATION
NO. OF CREDITS: 4

L	T	P		
			SESSIONAL	: 25
			FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-A is compulsory and contains 10 questions each of 1.5 marks covering the entire syllabus. Part-B has 6 questions each of 15 marks and students are required to attempt any four questions from this part.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

OELC201A.1 *Acquire knowledge about direct current (DC) and alternating current (AC) voltage and current measuring instruments.*

OELC201A.2 *Learn the construction, working and the applications of CRO and function generators.*

OELC201A.3 *Understand the working of transducer devices.*

OELC201A.4 *Examine the functioning of data acquisition systems and bio-medical instruments.*

OELC201A.5 *Investigate the computer controlled test and measurement system.*

OELC201A.6 *Explore the principles, working and applications of instrumentation in various fields and industry.*

Unit-I

DC and AC indicating Instruments: Accuracy and precision, Types of errors, PMMC galvanometer, sensitivity, Loading effect, Conversion of Galvanometer into ammeter, Voltmeter and Shunt type ohmmeter, Multimeter. (10 Lectures)

Unit-II

Oscilloscopes: CRT, wave form display and electrostatic focusing, time base and sweep synchronisation, measurement of voltage, frequency and phase by CRO, Oscilloscope probes, Dual trace oscilloscope, Sampling Oscilloscope, DSO and Powerscope: Block diagram, principle and working, Advantages and applications, CRO specifications (bandwidth, sensitivity, rise time).

Signal Generators: Audio oscillator, Pulse Generator, Function generators. (14 Lectures)

Unit-III

Transducers: Basic requirements of transducers, Transducers for measurement of non-electrical quantities: Types and their principle of working , measurement of Linear displacement, Acceleration, Flow rate, Liquid level, strain, Force, Pressure, Temperature. (10 Lectures)

UNIT-IV

Data acquisition systems: Block diagram, brief description of preamplifier, signal conditioner, instrumentation amplifier, waveform generator, A/D and D/A converter blocks, computer controlled test and measurement system.

Bio-medical instrumentation: Bio-Amplifiers: Bio potentials - Bio-electricity - Necessity for special types of amplifiers for biological signal amplifications - Different types of Bio- OP-Amps. Electrodes for ECG, EEG, and EMG, block diagram of ECG and EEG systems, brief analysis of graphs. (14 Lectures)

Reference Books:

1. Electrical Measurement in Measuring Instruments. Goldwing E.W. and Widdies.
2. Electrical and Electronics Measurement and Instrumentation Sahwany A.K.
3. Instrumentation devices and systems: Rangan, Sarma, Mani, TMH.
4. Instrumentation measurement and analysis: Nakra B C, Chaudry K K, TMH.
5. Handbook of biomedical instrumentation: Khandpur R S, TMH.
6. Measurement systems applications and design: Doeblin E O, McGraw Hill, 1990.
7. Electron measurements and instrumentation techniques: Cooper W D and Helfric A D, PHI, 1989.
8. Biomedical instrumentation and measurements: Leslie-Cromwell, Fred J Weibell, Erich A Pfieffer, PHI, 1994.
9. Mechatronics – principles and applications, Godfrey C Onwubolu, Elsevier, 2006.

SUGGESTED WEB SOURCES:

4. NPTEL :: Courses
5. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
6. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for OELC-201A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
OELC201A.1	3	1	3	3	3	3	1	2	1	2	2	-	2	1	1	3	3	2
OELC201A.2	3	-	2	2	2	3	-	2	-	-	-	-	-	-	-	3	3	2
OELC201A.3	3	-	3	3	3	3	-	3	-	-	1	-	-	-	-	3	3	2
OELC201A.4	3	2	3	3	3	3	1	3	1	2	2	-	2	2	1	3	3	2
OELC201A.5	3	2	3	3	3	3	2	3	1	2	2	-	2	2	1	3	3	2
OELC201A.6	3	2	3	3	3	3	2	3	1	2	2	-	2	2	1	3	3	2

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER II
CODE: OELC-202A
SUBJECT NAME: INSTRUMENTATION LAB
NO. OF CREDITS: 2

L	T	P		
			SESSIONAL	: 15
			FINAL EXAM	: 35
0	0	4	TOTAL	: 50

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

OELC202A.1 Learn the basics of instrumentation.

OELC202A.2 Determine the Characteristics of resistance transducer - Strain Gauge.

OELC202A.3 Examine the characteristics of linear variable differential transformer (LVDT), thermistors and resistance temperature detectors (RTD).

OELC202A.4 Design the multi range ammeter and voltmeter using galvanometer.

OELC202A.5 Analyze thermocouple and transducers like AD590 (two terminal temperature sensor), PT-100, J- type, K-type for temperature measurement.

OELC202A.6 Characterize bio-amplifier for ECG signals and analyze them.

OELC202A.7 Measure heart sound using electronic stethoscope.

OELC202A.8 Monitor pulse rate with alarm system and respiration rate using thermister /other electrodes.

At least 6 experiments from the following:

1. Design of multi range ammeter and voltmeter using galvanometer.
2. To determine the Characteristics of resistance transducer - Strain Gauge (Measurement of Strain using half and full bridge.)
3. To determine the Characteristics of LVDT.
4. To determine the Characteristics of Thermistors and RTD.
5. Measurement of temperature by Thermocouples and study of transducers like AD590 (two terminal temperature sensor), PT-100, J- type, K-type.
6. Characterization of bio potential amplifier for ECG signals.
7. Study on ECG simulator.
8. Measurement of heart sound using electronic stethoscope. Study on ECG heart rate monitor /simulator.

9. Study of pulse rate monitor with alarm system.
10. Measurement of respiration rate using thermister /other electrodes.

Reference Books:

1. Electrical Measurement in Measuring Instruments. Goldwing E.W. and Widdies.
2. Electrical and Electronics Measurement and Instrumentation Sahwany A.K.
3. Instrumentation devices and systems: Rangan, Sarma, Mani, TMH.
4. Instrumentation measurement and analysis: Nakra B C, Chaudry K K, TMH.
5. Handbook of biomedical instrumentation: Khandpur R S, TMH.
6. Measurement systems applications and design: Doeblin E O, McGraw Hill, 1990.
7. Electron measurements and instrumentation techniques: Cooper W D and Helfric A D, PHI, 1989.
8. Biomedical instrumentation and measurements: Leslie-Cromwell, Fred J Weibell, Erich A Pfieffer, PHI, 1994.

SUGGESTED WEB SOURCES:

2. Virtual Labs (vlab.co.in)

MODE OF TRANSACTION: Demonstration, E-tutoring, discussion; **LMS/ICT Tools:** Online Resources.

Mapping of CO and PO for OELC-202A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
OELC202A.1	3	1	2	2	3	3	3	1	1	2	2	-	2	2	2	3	3	2
OELC202A.2	3	2	3	3	3	3	3	3	1	3	3	-	3	3	2	3	3	3
OELC202A.3	3	2	3	3	3	3	3	3	1	3	3	-	3	3	2	3	3	3
OELC202A.4	3	2	3	3	3	3	3	3	1	3	3	-	3	3	2	3	3	3
OELC202A.5	3	2	3	3	3	3	3	3	1	3	3	-	3	3	2	3	3	3
OELC202A.6	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	3
OELC202A.7	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	3
OELC202A.8	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	3

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER II
CODE: OCHE-201A
SUBJECT NAME: PHYSICAL CHEMISTRY
NO. OF CREDITS: 4

L	T	P		
			SESSIONAL	: 25
			FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-A is compulsory and contains 10 questions each of 1.5 marks covering the entire syllabus. Part-B has 6 questions each of 15 marks and students are required to attempt any four questions from this part.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

OCHE201A.1 *Understand the basic concept of chemical thermodynamics.*

OCHE201A.2 *Determine the conditions of chemical equilibria and portrait the relationships between equilibrium constants.*

OCHE201A.3 *Analyze phase rule and phase equilibrium for one and two component systems.*

OCHE201A.4 *Learn the basics of electrochemistry and apply the concepts for improving the performance of cells.*

OCHE201A.5 *Understand the behaviour of ideal and non-ideal solutions and the governing laws.*

OCHE201A.6 *Solve the fundamental problems in physical chemistry.*

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. (10 Lectures)

Unit II

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. (14 Lectures)

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-component systems (water and sulphur) and two component systems involving eutectics, congruent and incongruent melting points (lead-silver, FeCl3-H2O and Na-Konly). (14 Lectures)

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). (10 Lectures)

Reference Books

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

SUGGESTED WEB SOURCES:

1. NPTEL :: Courses
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for OCHE-201A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
OCHE201A.1	3	2	2	3	3	3	1	3	-	-	1	-	-	-	-	2	1	-
OCHE201A.2	3	1	3	3	3	3	2	3	1	2	2	-	2	2	1	2	2	-
OCHE201A.3	3	1	3	3	3	3	2	3	1	2	2	-	2	2	1	2	2	-
OCHE201A.4	3	-	2	3	3	3	-	3	-	-	1	-	-	-	-	2	2	-
OCHE201A.5	3	1	3	3	3	3	1	3	1	2	2	-	2	2	1	2	2	-
OCHE201A.6	3	2	3	3	3	3	2	3	1	2	2	-	2	2	1	2	2	-

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER II
CODE: OCHE-202A
SUBJECT NAME: PHYSICAL CHEMISTRY LAB
NO. OF CREDITS: 2

			SESSIONAL	: 15
L	T	P	FINAL EXAM	: 35
0	0	4	TOTAL	: 50

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

OCHE202A.1 *Understand the basic concept of enthalpy.*

OCHE202A.2 *Determine the enthalpy change of electrolytes.*

OCHE202A.3 *Analyze the redox potential and EMF using Potentiometry.*

OCHE202A.4 *Determine the surface tension and viscosity.*

OCHE202A.5 *Learn a synthesis route of a polymer.*

OCHE202A.6 *Determine cell constant and conductance of solution.*

OCHE202A.7 *Expertise in the determination of enthalpy of ionization, hydration and neutralization.*

OCHE202A.8 *Evaluate the integral enthalpy of salt solution.*

The students have to perform at least 6 experiments from the following

1. Determination of enthalpy of ionization of ethanoic acid.
2. Determination of enthalpy of hydration of salt.
3. Study of solubility of benzoic acid in water and determine enthalpy change.
4. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
5. Determination of surface tension and viscosity.
6. Potentiometry- Determination of redox potential.
7. Determination of EMF using Potentiometry.
8. Determination of cell constant and conductance of solution.
9. Determination of integral enthalpy (endothermic or exothermic) solution of salt.
10. Synthesis of polymer.

Reference Books:

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

SUGGESTED WEB SOURCES:

1. Virtual Labs (vlab.co.in)

MODE OF TRANSACTION: Demonstration, E-tutoring, discussion; **LMS/ICT Tools:** Online Resources.

Mapping of CO and PO for OCHE-202A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
OCHE202A.1	3	1	1	3	2	3	1	3	-	-	1	1	1	1	1	2	1	1
OCHE202A.2	3	2	3	3	3	3	2	3	1	-	2	2	2	2	2	2	2	2
OCHE202A.3	3	2	3	3	3	3	2	3	1	-	2	2	2	2	2	2	2	2
OCHE202A.4	3	2	3	3	3	3	2	3	1	-	2	2	2	2	2	2	2	2
OCHE202A.5	3	2	3	3	3	3	2	3	1	-	2	2	2	2	2	2	2	2
OCHE202A.6	3	2	3	3	3	3	2	3	1	-	2	2	2	2	2	2	2	2
OCHE202A.7	3	2	3	3	3	3	2	3	1	-	2	2	2	2	2	2	2	2
OCHE202A.8	3	2	3	3	3	3	2	3	1	-	2	2	2	2	2	2	2	2

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

Syllabus of B.Sc. (H) Physics

Semester III

Discipline Core Course (DCC)

B.Sc. (H) PHYSICS SEMESTER III
CODE: BPH-301A
SUBJECT NAME: MATHEMATICAL PHYSICS-II
NO. OF CREDITS: 4

L	T	P		
			SESSIONAL	: 25
			FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-A is compulsory and contains 10 questions each of 1.5 marks covering the entire syllabus. Part-B has 6 questions each of 15 marks and students are required to attempt any four questions from this part.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

BPH301A.1 *Learn the Fourier analysis of periodic functions and their applications in simple physical problems.*

BPH301A.2 *Understand the differentiation and integration of Fourier series.*

BPH301A.3 *Solve linear second order differential equations using the power series method.*

BPH301A.4 *Learn about the special functions, such as the Hermite polynomial, the Legendre polynomial, the Laguerre polynomial and Bessel functions.*

BPH301A.5 *Analyze the differential equations of special functions and their applications in various physical problems.*

BPH301A.6 *Learn the beta and gamma functions and apply the basics for computation of integrations.*

Unit-I
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. Applications. Summing of Infinite Series. Term-by-Term differentiation and integration of Fourier Series. Parseval Identity. (12 Lectures)

Unit-II
Series Solutions for Second Order Differential Equations: Power series representation of functions. Ordinary and Singular Points of Second Order Linear Differential Equations and their

importance. Series solution about an ordinary point. . Series solution about a regular singular point. Frobenius method and its applications to differential equations. (12 Lectures)

Unit-III

Special Functions-I: ~~Legendre, Bessel, Hermite and Laguerre Differential Equations.~~ Bessel Functions: Bessel functions of the first kind Jn(x), Generating function, Recurrence relations, Expansion of Jn(x) when n is half an odd integer, Integral representation, Zeros of Bessel Functions ($J_o(x)$ and $J_1(x)$) and orthogonality; Legendre Polynomials Pn(x): Generating function, Recurrence relations and special properties, Rodrigues' formula, Orthogonality of Pn(x); Expansion of function in a series of Legendre Polynomials; Associated Legendre polynomials and their orthogonality. (12 Lectures)

Unit-IV

Special Function-II: Hermite Polynomials: generating function, recurrence relations and orthogonality; Laguerre Polynomials: generating function, recurrence relations and orthogonality.

Some Special Integrals: Beta Functions; Gamma Functions; Recursion relation; Gamma function of negative numbers; Relation between Beta and Gamma functions. Expression of Integrals in terms of Gamma Functions. (12 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.~~

Reference Books:

1. Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier. Fourier Analysis by M.R. Spiegel, 2004, Tata McGraw-Hill.
2. Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole. Differential Equations, George F. Simmons, 2006, Tata McGraw-Hill.
3. Engineering Mathematics, S.Pal and S.C. Bhunia, 2015, Oxford University Press
4. Mathematical Methods in the Physical Sciences, M.L. Boas, 2007, Wiley-India.
5. Mathematical methods for Scientists & Engineers, D.A.McQuarrie, 2003, Viva Books

SUGGESTED WEB SOURCES:

1. NPTEL :: Courses
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for BPH-301A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
BPH301A.1	3	-	2	2	2	3	-	1	1	-	-	-	-	-	-	3	2	1
BPH301A.2	3	-	2	2	2	3	-	2	1	-	2	-	-	-	-	3	2	1
BPH301A.3	3	1	3	3	3	3	1	3	1	2	2	-	2	-	1	3	3	2
BPH301A.4	3	-	2	2	2	3	-	1	1	-	1	-	-	-	-	3	2	1
BPH301A.5	3	1	3	3	3	3	2	3	1	2	2	-	2	-	1	3	3	2
BPH301A.6	3	-	2	2	2	3	-	2	1	-	1	-	-	-	-	3	2	1

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER III
CODE: BPH-302A
SUBJECT NAME: THERMAL PHYSICS
NO. OF CREDITS: 4

L	T	P		
			SESSIONAL	: 25
			FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-A is compulsory and contains 10 questions each of 1.5 marks covering the entire syllabus. Part-B has 6 questions each of 15 marks and students are required to attempt any four questions from this part.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

BPH302A.1 *Learn the fundamental laws of thermodynamics.*

BPH302A.2 *Understand the concept of internal energy, enthalpy, entropy and free energies.*

BPH302A.3 *Examine the principle and working of Carnot engines.*

BPH302A.4 *Determine thermodynamic potential and analyze maxwell's thermodynamic relations.*

BPH302A.5 *Understand and compare the behaviour of ideal and real gases.*

BPH302A.6 *Learn the basics of kinetic theory of gases and analyze the distribution of velocities in an ideal gas.*

~~**Introduction to Thermodynamics**~~

Unit-I

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.

(12 Lectures)

Unit-II

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, 2^{nd} 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.~~

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. (12 Lectures)

Unit-III

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

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.~~ (12 Lectures)

Unit-IV

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.~~

Kinetic Theory of Gases: 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.

(12 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.~~

Reference Books:

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

SUGGESTED WEB SOURCES:

1. NPTEL :: Courses
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for BPH-302A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
BPH302A.1	3	3	3	3	3	3	2	3	2	2	2	-	3	-	2	2	2	2
BPH302A.2	3	3	3	3	3	3	2	3	2	3	3	-	2	-	2	2	2	3
BPH302A.3	3	3	3	3	3	3	2	3	2	3	2	-	2	-	2	2	3	3
BPH302A.4	3	3	3	3	3	3	2	3	2	2	2	-	2	-	2	2	2	2
BPH302A.5	3	3	3	3	3	3	3	3	2	2	2	-	2	-	3	3	2	2
BPH302A.6	3	3	3	3	3	3	2	3	2	2	2	-	2	-	2	2	3	2

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER III
CODE: BPH-303A
SUBJECT NAME: ANALOG SYSTEMS AND APPLICATIONS
NO. OF CREDITS: 4

L	T	P		
			SESSIONAL	: 25
			FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-A is compulsory and contains 10 questions each of 1.5 marks covering the entire syllabus. Part-B has 6 questions each of 15 marks and students are required to attempt any four questions from this part.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

BPH303A.1 *Know the fundamentals of Semiconductor physics and P-N diodes.*

BPH303A.2 *Apply the knowledge of semiconductors and P-N diodes to understand the working of rectifiers and filters.*

BPH303A.3 *Understand and analyze the characteristics of BJT in various configurations.*

BPH303A.4 *Learn the process of amplification and feedback in amplifiers.*

BPH303A.5 *Understand the theory, working and applications of various oscillator circuits.*

BPH303A.6 *Have an understanding of the physics of Op-Amp and its applications*.

UNIT-I

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. (10 Lectures)

UNIT-II

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.

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. (10 Lectures)

UNIT-III

Amplifiers: Transistor Biasing and Stabilization Circuits. Need for bias stabilization, stability factor, Fixed Bias, Emitter feedback bias and Voltage Divider Bias. Transistor as 2-port Network, h-parameter Equivalent Circuit in CE configuration.h-parameters of Various transistors configurations (definition only). ~~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 (basic Idea).Two stage RC-coupled amplifier and its frequency response.

Feedback in Amplifiers: Positive and Negative Feedback. Effect of negative feedback on Input Impedance, Output Impedance, Gain, Stability, Distortion, Noise and band width.

Sinusoidal Oscillators: Barkhausen's Criterion for self-sustained oscillations. RC Phase shift oscillator, determination of Frequency.Hartley & Colpitts oscillators. (14 Lectures)

UNIT-IV

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

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. (14 Lectures)

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

Reference Books:

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

SUGGESTED WEB SOURCES:

1. NPTEL :: Courses
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for BPH-303A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
BPH303A.1	3	2	3	3	3	3	3	3	2	3	3	-	2	2	3	3	3	3
BPH303A.2	3	2	3	3	3	3	3	3	2	3	3	-	2	2	3	3	3	3
BPH303A.3	3	2	3	3	3	3	3	3	2	3	3	-	2	2	3	3	3	3
BPH303A.4	3	2	3	3	3	3	3	3	2	3	3	-	2	2	3	3	3	3
BPH303A.5	3	2	3	3	3	3	3	3	3	3	3	-	2	2	3	3	3	3
BPH303A.6	3	2	3	3	3	3	3	3	3	3	3	-	2	2	3	3	3	3

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER III
CODE: BPH-304A
SUBJECT NAME: MATHEMATICAL PHYSICS-II LAB
NO. OF CREDITS: 2

L	T	P		
			SESSIONAL	: 15
			FINAL EXAM	: 35
0	0	4	TOTAL	: 50

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

BPH304A.1 *Learn the basics of numerical computation software scilab.*

BPH304A.2 *Understand the curve fitting procedures using scilab.*

BPH304A.3 *Examine the solutions of first and second order differential equations using scilab.*

BPH304A.4 *Investigate the generation and plotting of special functions like Bessel's function and Legendre polynomial.*

BPH304A.5 *Derive the solutions of linear systems of equations using scilab.*

BPH304A.6 *Solve computationally the oscillator, newton's law of cooling, wave equation, heat equation, Poisson's equation, Laplace equation and mesh equations of electrical circuits.*

BPH304A.7 *Apply the hierarchy of operations and multidimensional arrays of scilab to simple problems in physics.*

BPH304A.8 *Explore the scilab proficiency in analyzing simple physics problems.*

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:

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

SUGGESTED WEB SOURCES:

1. Virtual Labs (vlab.co.in)

MODE OF TRANSACTION: Demonstration, E-tutoring, discussion; **LMS/ICT Tools:** Online Resources.

Mapping of CO and PO for BPH-304A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
BPH304A.1	3	1	2	2	3	3	3	2	1	3	2	-	2	2	2	3	3	2
BPH304A.2	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	3
BPH304A.3	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	3
BPH304A.4	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	3
BPH304A.5	3	2	3	3	3	3	3	3	1	3	2	-	2	2	2	3	3	2
BPH304A.6	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	3
BPH304A.7	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	3
BPH304A.8	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	3

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER III
CODE: BPH-305A
SUBJECT NAME: THERMAL PHYSICS LAB
NO. OF CREDITS: 2

L	T	P		
			SESSIONAL	: 15
0	0	4	FINAL EXAM	: 35
			TOTAL	: 50

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

BPH305A.1 *Learn the basics of thermodynamics.*

BPH305A.2 *Develop the equivalence between work and heat.*

BPH305A.3 *Examine the coefficient of thermal conductivity of good and bad conductors of heat.*

BPH305A.4 *Calibrate a thermocouple for a specific range of temperature.*

BPH305A.5 *Explore the principle and working of Platinum Resistance Thermometer.*

BPH305A.6 *Determine Stefan's Constant.*

BPH305A.7 *Measure Planck's constant using black body radiation*

BPH305A.8 *Analyze the cooling temperature of a hot object as a function of time using a thermocouple.*

At least 6 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.
8. To determine Stefan's Constant.
9. Measurement of Planck's constant using black body radiation.

10. To record and analyze the cooling temperature of a hot object as a function of time using a thermocouple and suitable data acquisition system.

Reference Books:

1. Advanced Practical Physics for students, B. L. Flint and H.T.Worsnop, 1971, Asia Publishing House
2. 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
3. A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal,1985, Vani Pub.

SUGGESTED WEB SOURCES:

1. Virtual Labs (vlab.co.in)

MODE OF TRANSACTION: Demonstration, E-tutoring, discussion; **LMS/ICT Tools:** Online Resources.

Mapping of CO and PO for BPH-305A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
BPH305A.1	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	3
BPH305A.2	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	3
BPH305A.3	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	3
BPH305A.4	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	3
BPH305A.5	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	3
BPH305A.6	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	3
BPH305A.7	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	3
BPH305A.8	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	3

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER III
CODE: BPH-306A
SUBJECT NAME: ANALOG SYSTEMS AND APPLICATIONS LAB
NO. OF CREDITS: 2

L	T	P		
			SESSIONAL	: 15
			FINAL EXAM	: 35
0	0	4	TOTAL	: 50

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

BPH306A.1 *Understand the V-I characteristics of Zener diode and solar cells.*

BPH306A.2 *Analyze the characteristics of a transistor and an amplifier.*

BPH306A.3 *Design the inverting and non-inverting amplifier using Op-amp.*

BPH306A.4 *Explore the functioning of Op-amp as an Integrator and a Differentiator.*

BPH306A.5 *Understand the theory and working of oscillator circuits for a specific response.*

BPH306A.6 *Design electronic circuits for the solution of simultaneous equation and differential equation.*

BPH306A.7 *Design a digital to analog converter (DAC) of given specifications.*

BPH306A.8 *Analyze voltage regulation using Zener diode.*

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:

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

SUGGESTED WEB SOURCES:

1. Virtual Labs (vlab.co.in)

MODE OF TRANSACTION: Demonstration, E-tutoring, discussion; **LMS/ICT Tools:** Online Resources.

Mapping of CO and PO for BPH-306A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
BPH306A.1	3	2	3	3	3	3	3	3	2	3	3	-	2	2	3	3	3	3
BPH306A.2	3	2	3	3	3	3	3	3	2	3	3	-	2	2	3	3	3	3
BPH306A.3	3	2	3	3	3	3	3	3	2	3	3	-	2	2	3	3	3	3
BPH306A.4	3	2	3	3	3	3	3	3	2	3	3	-	2	2	3	3	3	3
BPH306A.5	3	2	3	3	3	3	3	3	3	3	3	-	2	2	3	3	3	3
BPH306A.6	3	2	3	3	3	3	3	3	3	3	3	-	2	2	3	3	3	3
BPH306A.7	3	2	3	3	3	3	3	3	3	3	3	-	2	2	3	3	3	3
BPH306A.8	3	2	3	3	3	3	3	3	3	3	3	-	2	2	3	3	3	3

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

Open Elective Courses (OEC)

B.Sc. (H) PHYSICS SEMESTER III
CODE: OMTH-301A
SUBJECT NAME: DIFFERENTIAL EQUATIONS
NO. OF CREDITS: 6

L	T	P		
			SESSIONAL	: 25
			FINAL EXAM	: 75
5	1	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-A is compulsory and contains 10 questions each of 1.5 marks covering the entire syllabus. Part-B has 6 questions each of 15 marks and students are required to attempt any four questions from this part.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

OMTH301A.1 *Learn the basics of rodinary differential equations.*

OMTH301A.2 *Solve exact differential equations and linear differential equations.*

OMTH301A.3 *Explore the solution of homogenous system of differential equations.*

OMTH301A.4 *Predict general solutions of first order partial differential equations.*

OMTH301A.5 *Classify second order partial differential equations and reduce them to canonical forms.*

OMTH301A.6 *Examine existence and uniqueness of solutions of ordinary and partial 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 (12 Lectures)

UNIT-II

Second order differential equations: Homogenous linear equations of second order, Second order homogenous equations with constant coefficients, Differential operator, Euler-Cauchy equation.

(12 Lectures)

UNIT-III

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.~~ solution of homogeneous system of differential equations.

~~Power series method: Theory of power series methods, Solution of differential equations by power series method, Legendre's equation, Legendre polynomial.~~ (10 Lectures)

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. (14 Lectures)

Reference Books:

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

SUGGESTED WEB SOURCES:

1. NPTEL :: Courses
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for OMTH-301A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
OMTH301A.1	3	1	2	2	2	3	1	1	-	-	1	-	-	1	-	2	1	-
OMTH301A.2	3	2	3	3	3	3	2	3	1	2	2	-	2	2	1	2	3	-
OMTH301A.3	3	2	3	3	3	3	2	3	1	2	2	-	2	2	1	2	3	-
OMTH301A.4	3	2	3	3	3	3	2	3	1	2	2	-	2	2	1	2	3	-
OMTH301A.5	3	2	3	3	3	3	2	3	1	2	2	-	2	2	1	2	3	-
OMTH301A.6	3	2	3	3	3	3	2	3	1	2	2	-	2	2	1	2	3	-

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER III
CODE: OELC-301A
SUBJECT NAME: COMMUNICATION SYSTEMS
NO. OF CREDITS: 4

L	T	P		
			SESSIONAL	: 25
			FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-A is compulsory and contains 10 questions each of 1.5 marks covering the entire syllabus. Part-B has 6 questions each of 15 marks and students are required to attempt any four questions from this part.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

OELC301A.1 *Learn amplitude modulation and demodulation techniques.*

OELC301A.2 *Understand frequency modulation and demodulation techniques.*

OELC301A.3 *Learn various digital communication techniques.*

OELC301A.4 *Examine cellular communication and satellite communication.*

OELC301A.5 *Understand advantage and disadvantages of digital transmission.*

OELC301A.6 *Figure noise in transmission lines.*

Unit-I
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. (10 Lectures)

Unit-II
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. (10 Lectures)

Unit- III

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. (14 Lectures)

Unit- IV

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. (14 Lectures)

Reference 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.

SUGGESTED WEB SOURCES:

1. NPTEL :: Courses
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for OELC-301A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
OELC301A.1	3	-	3	3	3	3	-	2	-	-	-	-	-	-	-	3	3	-
OELC301A.2	3	-	3	3	3	3	-	2	-	2	2	-	2	2	1	3	3	-
OELC301A.3	3	-	3	3	3	3	-	2	-	-	-	-	-	-	-	3	3	-
OELC301A.4	3	2	2	3	3	3	2	3	1	2	2	-	2	2	1	3	3	-
OELC301A.5	3	-	3	3	3	3	-	2	-	2	2	-	-	-	-	3	3	-
OELC301A.6	3	2	2	3	3	3	2	3	1	2	2	-	2	2	1	3	3	-

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER III
CODE: OELC-302A
SUBJECT NAME: COMMUNICATION SYSTEMS LAB
NO. OF CREDITS: 2

L	T	P		
			SESSIONAL	: 15
L	T	P	FINAL EXAM	: 35
0	0	4	TOTAL	: 50

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

OELC302A.1 *Learn amplitude modulation and demodulation techniques.*

OELC302A.2 *Analyze Amplitude Modulation and Frequency Modulation Transmitter/Receiver*.

OELC302A.3 *Understand Time Division Multiplexing and de multiplexing*.

OELC302A.4 *Examine Pulse-Amplitude Modulation (PAM) modulator and demodulator*.

OELC302A.5 *Analyze Frequency-Shift Keying (FSK) modulation.*

OELC302A.6 *Explore pulse and digital communication types.*

OELC302A.7 *Portray the working of Voltage Controlled Oscillator (VCO) using IC 566.*

OELC302A.8 *Analyze Frequency Modulation (FM) using IC8038.*

At least 06 experiments from the following:

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

Reference 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.

SUGGESTED WEB SOURCES:

1. Virtual Labs (vlab.co.in)

MODE OF TRANSACTION: Demonstration, E-tutoring, discussion; **LMS/ICT Tools:** Online Resources.

Mapping of CO and PO for OELC-302A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
OELC302A.1	3	1	2	2	3	3	3	1	1	2	2	-	2	2	2	3	3	2
OELC302A.2	3	2	3	3	3	3	3	2	1	2	2	-	2	2	2	3	3	2
OELC302A.3	3	2	3	3	3	3	3	2	1	3	3	-	3	3	2	3	3	3
OELC302A.4	3	2	3	3	3	3	3	2	1	3	3	-	3	3	2	3	3	3
OELC302A.5	3	2	3	3	3	3	3	2	1	3	3	-	3	3	2	3	3	3
OELC302A.6	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	3
OELC302A.7	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	3
OELC302A.8	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	3

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER III
CODE: OCHE-301A
SUBJECT NAME: ORGANIC CHEMISTRY
NO. OF CREDITS: 4

L	T	P		
			SESSIONAL	: 25
4	0	0	FINAL EXAM	: 75
			TOTAL	: 100

NOTE: Question paper will have two parts. Part-A is compulsory and contains 10 questions each of 1.5 marks covering the entire syllabus. Part-B has 6 questions each of 15 marks and students are required to attempt any four questions from this part.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

OCHE301A.1	*Learn the fundamentals of organic chemistry.*
OCHE301A.2	*Understand the basics of stereochemistry and differentiate various isomers.*
OCHE301A.3	*Examine the reaction mechanisms of various organic compounds.*
OCHE301A.4	*Analyze the chemical properties of organic compounds.*
OCHE301A.5	*Learn the preparation methods of different organic compounds.*
OCHE301A.6	*Apply the basics of organic chemistry to design the chemical reactions of various functional groups.*

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). (12 Lectures)

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. KMnO4) andtrans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymecuration-demercuration, Hydroboration-oxidation.

Alkynes: *Preparation:* Acetylene from CaC2 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 KMnO4, ozonolysis and oxidation with hot alk. KMnO4. Hydration to form carbonyl compounds.

(12 Lectures)

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. (12 Lectures)

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. (12 Lectures)

Reference Books:

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

SUGGESTED WEB SOURCES:

1. NPTEL :: Courses
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for OCHE-301A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
OCHE301A.1	3	1	2	3	3	3	1	3	-	-	2	-	2	-	-	2	2	-
OCHE301A.2	3	2	3	3	3	3	2	3	1	2	2	-	2	2	1	2	2	-
OCHE301A.3	3	2	3	3	3	3	2	3	1	2	2	-	2	2	1	2	2	-
OCHE301A.4	3	2	3	3	3	3	2	3	1	2	2	-	2	2	1	2	2	-
OCHE301A.5	3	1	2	3	3	3	1	3	-	-	2	-	2	-	-	2	2	-
OCHE301A.6	3	2	3	3	3	3	2	3	1	2	2	-	2	2	1	2	2	-

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER III
CODE: OCHE-302A
SUBJECT NAME: ORGANIC CHEMISTRY LAB
NO. OF CREDITS: 2

L	T	P		
			SESSIONAL	: 15
			FINAL EXAM	: 35
0	0	4	TOTAL	: 50

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

OCHE302A.1 *Learn the basics of identification of functional groups.*
OCHE302A.2 *Analyze the unknown organic compound containing aromatic groups.*
OCHE302A.3 *Analyze the unknown organic compound containing alcohols and phenols.*
OCHE302A.4 *Examine the unknown organic compound containing aldehydes.*
OCHE302A.5 *Identify the unknown organic compound containing ketones.*
OCHE302A.6 *Examine oxidation of ethanol/isopropanol*.
OCHE302A.7 *Investigate condensation reactions of aldehydes*.
OCHE302A.8 *Explore the acylation reaction of phenols*.

The students have to perform at least 6 experiments from the following

1. Qualitative analysis of unknown organic compounds containing aryl halides.
2. Qualitative analysis of unknown organic compounds containing aromatic hydrocarbons.
3. Qualitative analysis of unknown organic compounds containing alcohols.
4. Qualitative analysis of unknown organic compounds containing aldehydes.
5. Qualitative analysis of unknown organic compounds containing ketones.
6. Qualitative analysis of unknown organic compounds containing phenols.
7. Oxidation of ethanol/isopropanol (Iodoform reaction).
8. Aldol condensation using either conventional or green methods.
9. Semicarbazone of any one of the following compounds: acetone, ethyl methyl ketone, cyclohexanone and benzaldehyde.
10. Acylation of phenols.

Reference Books:

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

SUGGESTED WEB SOURCES:

1. Virtual Labs (vlab.co.in)

MODE OF TRANSACTION: Demonstration, E-tutoring, discussion; **LMS/ICT Tools:** Online Resources.

Mapping of CO and PO for OCHE-302A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
OCHE302A.1	3	1	1	3	2	3	1	3	-	-	1	1	1	1	1	2	1	1
OCHE302A.2	3	2	3	3	3	3	2	3	1	-	2	2	2	2	2	2	2	2
OCHE302A.3	3	2	3	3	3	3	2	3	1	-	2	2	2	2	2	2	2	2
OCHE302A.4	3	2	3	3	3	3	2	3	1	-	2	2	2	2	2	2	2	2
OCHE302A.5	3	2	3	3	3	3	2	3	1	-	2	2	2	2	2	2	2	2
OCHE302A.6	3	2	3	3	3	3	2	3	1	-	2	2	2	2	2	2	2	2
OCHE302A.7	3	2	3	3	3	3	2	3	1	-	2	2	2	2	2	2	2	2
OCHE302A.8	3	2	3	3	3	3	2	3	1	-	2	2	2	2	2	2	2	2

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER III
CODE: OCSC-301A
SUBJECT NAME: COMPUTER NETWORKS AND INTERNET TECHNOLOGIES
NO. OF CREDITS: 4

L	T	P		
			SESSIONAL	: 25
			FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-A is compulsory and contains 10 questions each of 1.5 marks covering the entire syllabus. Part-B has 6 questions each of 15 marks and students are required to attempt any four questions from this part.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

OCSC301A.1 *Understand basic computer network technology, different types of network topologies and protocols.*

OCSC301A.2 *Enumerate the layers of the OSI model and TCP/IP*

OCSC301A.3 *Analyze the services and features of the various layers of data networks.*

OCSC301A.4 *Learn services and protocols of physical and data link layer and understand IEEE 802 standards.*

OCSC301A.5 *Design, calculate, and apply subnet masks and addresses to fulfill networking requirements.*

OCSC301A.6 *Create web pages using HTML and JavaScript.*

UNIT-I

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.

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

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

LAN Topologies : Ring, Bus, Star , Mesh and tree topologies.

Network Devices: NIC, repeaters, hub, bridge, switch, gateway and router. (12 Lectures)

UNIT-II

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

Internet Applications: www, telnet, ftp, e-mail, social networks, search engines, Video Conferencing, e-Commerce, m-Commerce, VOIP, blogs. (10 Lectures)

UNIT-III

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. (14 Lectures)

UNIT-IV

JavaScript Fundamentals: Data types and variables, functions, methods and events, controlling program flow, JavaScript object model, built-in objects and operators. (12 Lectures)

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

SUGGESTED WEB SOURCES:

1. NPTEL :: Courses
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for OCSE-301A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
OCSE301A.1	3	2	3	3	2	3	1	2	-	3	1	-	-	1	2	2	1	-
OCSE301A.2	3	2	3	3	3	3	2	3	-	3	2	-	2	2	2	2	2	-
OCSE301A.3	3	2	3	3	3	3	2	3	-	3	2	-	2	2	2	2	2	-
OCSE301A.4	3	1	3	2	2	3	1	2	-	3	1	-	-	1	2	2	1	-
OCSE301A.5	3	2	3	3	3	3	2	3	-	3	2	2	2	2	2	2	2	-
OCSE301A.6	3	2	3	3	3	3	2	3	-	3	2	2	2	2	2	2	2	-

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER III
CODE: OCSC-302A
SUBJECT NAME: COMPUTER NETWORKS AND INTERNET TECHNOLOGIES LAB
NO. OF CREDITS: 2

			SESSIONAL	: 15
L	T	P	FINAL EXAM	: 35
0	0	4	TOTAL	: 50

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

OCSC302A.1 Learn the basics of HTML document and Javascript.

OCSC302A.2 Examine the creation of HTML document in various formats.

OCSC302A.3 Explore the Javascript for simple algebraic problems.

OCSC302A.4 Create tables and forms using HTML.

OCSC302A.5 Sort numbers form a given set using Javascript.

OCSC302A.6 Apply HTML and Javascript for the creation of webpages.

OCSC302A.7 Introduce different effects in website of 6 – 7 pages using HTML.

OCSC302A.8 Generate multiple frames in HTML documents.

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.

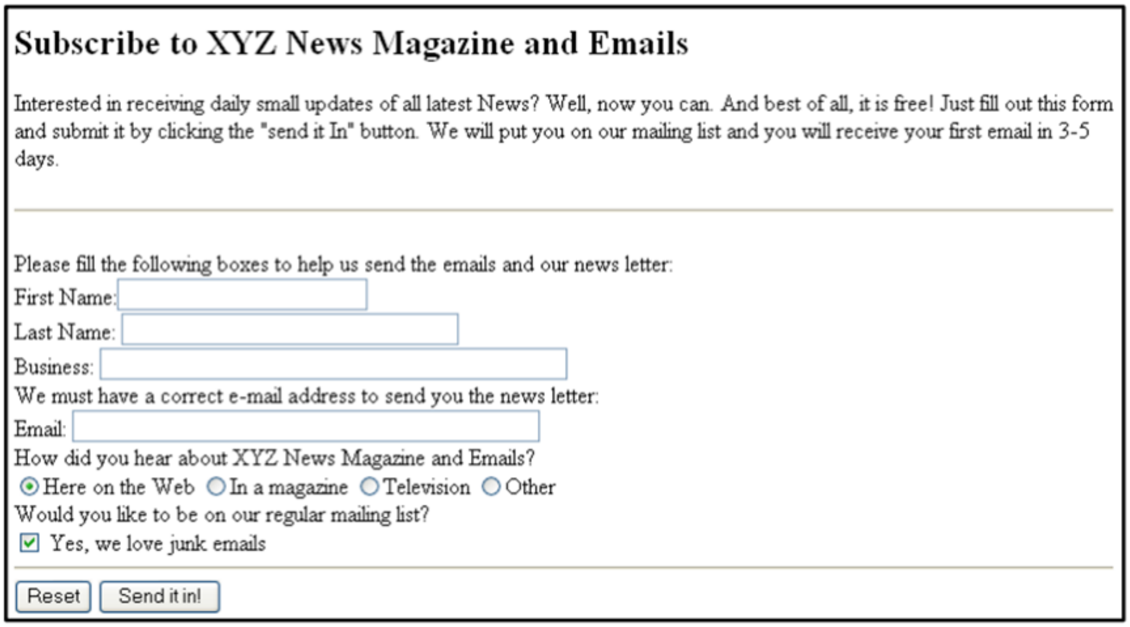
9. Create HTML documents (having multiple frames) in the following formats

Frame 1
Frame 2

Frame 1	
Frame 2	Frame 3

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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Yes, we love junk emails
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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.

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

SUGGESTED WEB SOURCES:

1. [Virtual Labs (vlab.co.in)]

MODE OF TRANSACTION: Demonstration, E-tutoring, discussion; **LMS/ICT Tools:** Online Resources.

Mapping of CO and PO for OCSE-302A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
OCSE302A.1	3	1	3	2	2	3	2	2	-	3	1	1	-	1	2	2	1	-
OCSE302A.2	3	2	2	3	3	3	2	2	-	3	2	2	2	2	2	2	2	-
OCSE302A.3	3	2	2	3	3	3	2	2	-	3	2	2	2	2	2	2	2	-
OCSE302A.4	3	2	2	3	3	3	2	2	-	3	2	2	2	2	2	2	2	-
OCSE302A.5	3	2	2	3	3	3	2	2	-	3	2	2	2	2	2	2	2	-
OCSE302A.6	3	2	2	3	3	3	2	2	-	3	2	2	2	2	2	2	2	-
OCSE302A.7	3	2	2	3	3	3	2	2	-	3	2	2	2	2	2	2	2	-
OCSE302A.8	3	2	2	3	3	3	2	2	-	3	2	2	2	2	2	2	2	-

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

Syllabus of B.Sc. (H) Physics

Semester IV

Discipline Core Course (DCC)

B.Sc. (H) PHYSICS SEMESTER IV
CODE: BPH-401A
SUBJECT NAME: MATHEMATICAL PHYSICS-III
NO. OF CREDITS: 4

L	T	P		
			SESSIONAL	: 25
			FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-A is compulsory and contains 10 questions each of 1.5 marks covering the entire syllabus. Part-B has 6 questions each of 15 marks and students are required to attempt any four questions from this part.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

BPH401A.1	*Learn the concepts of complex numbers, function of complex variables and analyze their singularities.*
BPH401A.2	*Perform integration of functions of complex variables.*
BPH401A.3	*Understand the basics of Fourier and Laplace Transforms.*
BPH401A.4	*Solve simple physics problems using Fourier and Laplace Transforms.*
BPH401A.5	*Analyze theorems involving integral transforms and their applications.*
BPH401A.6	*Develop the skills of solving various physics problems entailing complex variables, functions of complex variables and their integrals, and integral transforms.*

Unit-I
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. (12 Lectures)

Unit-II
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. (12 Lectures)

Unit-III
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. (12 Lectures)

Unit-IV

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. (12 Lectures)

Reference Books:

1. Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3^{rd} ed., 2006, Cambridge University Press
2. Mathematics for Physicists, P.Dennery and A.Krzywicki, 1967, Dover Publications
3. Complex Variables, A.S.Fokas & M.J.Ablowitz, 8^{th} Ed., 2011, Cambridge Univ. Press Complex Variables, A.K. Kapoor, 2014, Cambridge Univ. Press
4. Complex Variables and Applications, J.W.Brown & R.V.Churchill, 7^{th} Ed. 2003, Tata McGraw-Hill.

SUGGESTED WEB SOURCES:

1. NPTEL :: Courses
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for BPH-401A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
BPH401A.1	3	-	2	2	2	3	-	1	1	-	-	-	-	-	-	3	2	1
BPH401A.2	3	1	3	3	3	3	-	2	1	-	2	-	-	-	-	3	2	1
BPH401A.3	3	-	2	2	2	3	-	1	1	-	1	-	-	-	-	3	3	2
BPH401A.4	3	1	3	3	3	3	1	2	1	2	2	-	2	-	1	3	2	1
BPH401A.5	3	1	3	3	3	3	2	2	1	2	2	-	2	-	1	3	3	2
BPH401A.6	3	1	3	3	3	3	2	3	1	2	2	-	2	-	2	3	2	1

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER IV
CODE: BPH-402A
SUBJECT NAME: ELEMENTS OF MODERN PHYSICS
NO. OF CREDITS: 4

L	T	P		
			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-A is compulsory and contains 10 questions each of 1.5 marks covering the entire syllabus. Part-B has 6 questions each of 15 marks and students are required to attempt any four questions from this part.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

BPH402A.1 *Know the basic concepts of old Quantum theory.*
BPH402A.2 *Understand the interference and basics of the wave theory.*
BPH402A.3 *Learn the basic properties of nucleus and nuclear binding energy.*
BPH402A.4 *Have an understanding of Nuclear radioactivity laws and basics of Lasers.*
BPH402A.5 *Apply the concepts of Nuclear physics in understanding different models.*
BPH402A.6 *Acquire conceptual understanding of Quantum mechanical scattering and tunneling.*

Unit-I
Basics of Quantum Mechanics: 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.~~
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. (12 Lectures)

Unit-II
Quantum Mechanics and its applications: Two slit interference experiment with photons, atoms and particles; linear superposition principle ~~as a consequence~~; Matter waves and wave amplitude; Schrodinger wave 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.
Particle in a 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. (12 Lectures)

Unit-III

Nuclear Physics: 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. Nuclear Fission, Nuclear Fission reactor and Nuclear Fusion. (12 Lectures)

Unit-IV

Radioactivity and Lasers: ~~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.

Lasers: Metastable states. Spontaneous and Stimulated emissions. Einstein Coefficients, Optical Pumping and Population Inversion. Properties of Lasers, Basic lasing system. (12 Lectures)

Reference Books:

1. Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
2. Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGraw Hill
3. Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.
4. Modern Physics, G.Kaur and G.R. Pickrell, 2014, McGraw Hill

SUGGESTED WEB SOURCES:

1. NPTEL :: Courses
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for BPH-402A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
BPH402A.1	3	1	2	2	3	3	3	2	1	3	2	-	2	2	2	3	3	2
BPH402A.2	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	2
BPH402A.3	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	2
BPH402A.4	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	2
BPH402A.5	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	2
BPH402A.6	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	2

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER IV
CODE: BPH-403A
SUBJECT NAME: DIGITAL SYSTEMS AND APPLICATIONS
NO. OF CREDITS: 4

L	T	P		
			SESSIONAL	: 25
			FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-A is compulsory and contains 10 questions each of 1.5 marks covering the entire syllabus. Part-B has 6 questions each of 15 marks and students are required to attempt any four questions from this part.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

BPH403A.1 *Learn the fundamentals of digital logic gate- circuits and Boolean algebra.*

BPH403A.2 *Understand the circuitry, working and applications of data processing circuits and arithmetic circuits.*

BPH403A.3 *Learn the theory and working principle of basic sequential circuits like flip-flops of various types.*

BPH403A.4 *Apply the knowledge of flip-flops to various shift registers, counters and their applications.*

BPH403A.5 *Understand the working of Timer ICs, Memory ICs and their applications.*

BPH403A.6 *Learn the basics of microprocessor and assembly Language.*

UNIT-I
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. (10 Lectures)

UNIT-II
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.
Data processing circuits: Multiplexers, De-multiplexers, Decoders, Encoders. (10 Lectures)

UNIT-III
Arithmetic Circuits: Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders. Half & Full Subtractors, 4-bit binary Adder/Subtractor.

Sequential Circuits: SR latch using NAND and NOR gates, 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.
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).
Counters(4 bits): Ring Counter. Asynchronous counters, Decade Counter. Synchronous Counter.
Timers: IC 555: block diagram and applications: Astable multivibrator and Monostable multivibrator.
~~**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 ICs.~~
Conversion: D/A Resistive networks (Weighted and R-2R Ladder). A/D conversion, Accuracy and Resolution. (16 Lectures)

UNIT-IV
Memory Organization: Structure of computer memory, Data storage (idea of RAM and ROM). Types of ROM: PROM, EPROM, EEPROM; Types of RAM- Static and dynamic RAM. Computer memory.~~Memory organization and addressing.Memory Map~~.
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.~~
Introduction to Assembly Language: 1 byte, 2 byte and 3 byte instructions. (12 Lectures)

Reference Books:

1. Digital Principles and Applications, A.P.Malvino, D.P. Leach and Saha, 7th Ed., 2011, Tata McGraw
2. Fundamentals of Digital Circuits, Anand Kumar, 2nd Edn, 2009, PHI Learning Pvt. Ltd.
3. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
4. Digital Electronics G K Kharate ,2010, Oxford University Press Logic circuit design, Shimon P. Vingron, 2012, Springer.
5. Microprocessor Architecture Programming & applications with 8085, 2002, R.S. Goankar, Prentice Hall.

SUGGESTED WEB SOURCES:

1. NPTEL :: Courses
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for BPH-403A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
BPH403A.1	3	1	3	3	3	3	3	3	2	3	3	-	2	2	3	3	3	3
BPH403A.2	3	1	3	3	3	3	3	3	2	3	3	-	2	2	3	3	3	3
BPH403A.3	3	1	3	3	3	3	3	3	2	3	3	-	2	2	3	3	3	3
BPH403A.4	3	1	3	3	3	3	3	3	2	3	3	-	2	2	3	3	3	3
BPH403A.5	3	1	3	3	3	3	3	3	3	3	3	-	2	2	3	3	3	3
BPH403A.6	3	1	3	3	3	3	3	3	3	3	3	-	2	2	3	3	3	3

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER IV
CODE: BPH-404A
SUBJECT NAME: MATHEMATICAL PHYSICS-III LAB
NO. OF CREDITS: 2

L	T	P		
			SESSIONAL	: 15
			FINAL EXAM	: 35
0	0	4	TOTAL	: 50

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

BPH404A.1 *Learn the computational skills of numerical modelling and simulation using scilab software.*
BPH404A.2 *Understand the behavior of special functions like Bessel's and Legendre, using scilab.*
BPH404A.3 *Examine the solutions of first and second order differential equations using scilab.*
BPH404A.4 *Evaluate the Dirac Delta Function using scilab.*
BPH404A.5 *Investigate the Frobenius method and Fourier series solutions using scilab.*
BPH404A.6 *Analyze curve fitting procedures and perform Integral transform using scilab.*
BPH404A.7 *Estimate error in a set of data recorded in a physics experiment.*
BPH404A.8 *Explore the scilab proficiency in analyzing simple physics problems.*

At least 6 experiments from the following:

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:

1. Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press
2. 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
3. A Guide to MATLAB, B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, 2014, 3rd Edn., Cambridge University Press
4. Getting started with Matlab, Rudra Pratap, 2010, Oxford University Press.

SUGGESTED WEB SOURCES:

1. Virtual Labs (vlab.co.in)

MODE OF TRANSACTION: Demonstration, E-tutoring, discussion; **LMS/ICT Tools:** Online Resources.

Mapping of CO and PO for BPH-404A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
BPH404A.1	3	1	2	2	3	3	3	2	1	3	2	-	2	2	2	3	3	2
BPH404A.2	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	3
BPH404A.3	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	3
BPH404A.4	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	3
BPH404A.5	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	3
BPH404A.6	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	3
BPH404A.7	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	3
BPH404A.8	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	3

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER IV
CODE: BPH-405A
SUBJECT NAME: MODERN PHYSICS LAB
NO. OF CREDITS: 2

L	T	P		
			SESSIONAL	: 15
L	T	P	FINAL EXAM	: 35
0	0	4	TOTAL	: 50

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

BPH405A.1	*Learn the basic concepts of modern physics.*
BPH405A.2	*Determine the wavelength and angular spread of laser light using the diffraction method.*
BPH405A.3	*Validate experimentally the value of Planck's constant.*
BPH405A.4	*Understand Photo-electric effect by plotting photo current versus intensity and wavelength of light and maximum energy of photo-electrons versus frequency of light.*
BPH405A.5	*Investigate the rotational spectrum of Iodine vapour.*
BPH405A.6	*Derive the work function of materials.*
BPH405A.7	*Design the Millikan drop apparatus to determine the charge of an electron.*
BPH405A.8	*Examine wavelength of H-alpha emission line of Hydrogen atom.*

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:

1. Advanced Practical Physics for students, B.L. Flint and H.T.Worsnop, 1971, Asia Publishing House
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
3. A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Edn, 2011,Kitab Mahal

SUGGESTED WEB SOURCES:

1. Virtual Labs (vlab.co.in)

MODE OF TRANSACTION: Demonstration, E-tutoring, discussion; **LMS/ICT Tools:** Online Resources.

Mapping of CO and PO for BPH-405A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
BPH405A.1	3	1	2	2	3	3	3	2	1	3	2	-	2	2	2	3	3	2
BPH405A.2	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	2
BPH405A.3	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	2
BPH405A.4	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	2
BPH405A.5	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	2
BPH405A.6	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	2
BPH405A.7	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	2
BPH405A.8	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	2

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER IV
CODE: BPH-406A
SUBJECT NAME: DIGITAL SYSTEMS & APPLICATIONS LAB
NO. OF CREDITS: 2

L	T	P		
			SESSIONAL	: 15
			FINAL EXAM	: 35
0	0	4	TOTAL	: 50

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

BPH406A.1 *Learn the working of Digital circuits and logic gates.*

BPH406A.2 *Understand the various arithmetic circuits like adders, subtractors, binary adders etc.*

BPH406A.3 *Design multivibrator of given specifications using 555 Timer.*

BPH406A.4 *Implement and investigate combinational logic systems.*

BPH406A.5 *Design various flip-flop circuits using logic gates and ICs.*

BPH406A.6 *Understand the basic 1-byte, 2-byte programming using 8085 Microprocessor.*

BPH406A.7 *Design combinational logic system for a specified Truth Table.*

BPH406A.8 *Build 4-bit Counter and shift register using D-type/JK Flip-Flop ICs.*

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:

1. Modern Digital Electronics, R.P. Jain, 4th Edition, 2010, Tata McGraw Hill.
2. Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.
3. Microprocessor Architecture Programming and applications with 8085, R.S. Goankar, 2002, Prentice Hall.
4. Microprocessor 8085:Architecture, Programming and interfacing, A.Wadhwa, 2010, PHI Learning.

SUGGESTED WEB SOURCES:

1. Virtual Labs (vlab.co.in)

MODE OF TRANSACTION: Demonstration, E-tutoring, discussion; **LMS/ICT Tools:** Online Resources.

Mapping of CO and PO for BPH-406A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
BPH406A.1	3	1	3	3	3	3	3	3	2	3	3	-	2	2	3	3	3	3
BPH406A.2	3	1	3	3	3	3	3	3	2	3	3	-	2	2	3	3	3	3
BPH406A.3	3	1	3	3	3	3	3	3	2	3	3	-	2	2	3	3	3	3
BPH406A.4	3	1	3	3	3	3	3	3	2	3	3	-	2	2	3	3	3	3
BPH406A.5	3	1	3	3	3	3	3	3	3	3	3	-	2	2	3	3	3	3
BPH406A.6	3	1	3	3	3	3	3	3	3	3	3	-	2	2	3	3	3	3
BPH406A.7	3	1	3	3	3	3	3	3	3	3	3	-	2	2	3	3	3	3
BPH406A.8	3	1	3	3	3	3	3	3	3	3	3	-	2	2	3	3	3	3

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

Open Elective Courses (OEC)

B.Sc. (H) PHYSICS SEMESTER IV
CODE: OMTH-401A
SUBJECT NAME: NUMERICAL METHODS
NO. OF CREDITS: 6

L	T	P		
			SESSIONAL	: 25
			FINAL EXAM	: 75
5	1	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-A is compulsory and contains 10 questions each of 1.5 marks covering the entire syllabus. Part-B has 6 questions each of 15 marks and students are required to attempt any four questions from this part.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

OMTH401A.1 *Understand about the solution of algebraic equations, transcendental equations and simultaneous algebraic equations.*

OMTH401A.2 *Analyze 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.*

OMTH401A.3 *Examine the solutions of Trapezoidal rule, Simpson's 1/3rd and 3/8th rules, Boole's rule and Weddle's rule.*

OMTH401A.4 *Solve numerically the ordinary differential equations.*

OMTH401A.5 *Determine solutions of simultaneous algebraic equations.*

OMTH401A.6 *Predict numerical solutions of differentiation and integration.*

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.~~ (15 Lectures)

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. (15 Lectures)

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~~. (15 Lectures)

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). (15 Lectures)

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.

SUGGESTED WEB SOURCES:

1. NPTEL :: Courses
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for OMTH-401A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
OMTH401A.1	3	2	3	3	3	3	2	3	1	2	2	-	2	2	1	2	3	-
OMTH401A.2	3	2	3	3	3	3	2	3	1	2	2	-	2	2	1	2	3	-
OMTH401A.3	3	2	3	3	3	3	2	3	1	2	2	-	2	2	1	2	3	-
OMTH401A.4	3	2	3	3	3	3	2	3	1	2	2	-	2	2	1	2	3	-
OMTH401A.5	3	2	3	3	3	3	2	3	1	2	2	-	2	2	1	2	3	-
OMTH401A.6	3	2	3	3	3	3	2	3	1	2	2	-	2	2	1	2	3	-

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER IV
CODE: OELC-401A
SUBJECT NAME: MICROPROCESSOR AND MICROCONTROLLER SYSTEM
NO. OF CREDITS: 4

L	T	P		
			SESSIONAL	: 25
4	0	0	FINAL EXAM	: 75
			TOTAL	: 100

NOTE: Question paper will have two parts. Part-A is compulsory and contains 10 questions each of 1.5 marks covering the entire syllabus. Part-B has 6 questions each of 15 marks and students are required to attempt any four questions from this part.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

OELC401A.1 *Know the number system and basics of microprocessor 8085.*
OELC401A.2 *Learn the basic programming instructions of 8085 microprocessor.*
OELC401A.3 *Examine the interfacing of various I/O devices.*
OELC401A.4 *Learn the basics of Microcontroller, counters and timers.*
OELC401A.5 *Analyze the working of Microcontroller, counters and timers.*
OELC401A.6 *Explore the instructions set and operations of 8085 microprocessor.*

Unit-1

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. (12 Lectures)

Unit-2

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.

(12 Lectures)

Unit-3

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.

(10 Lectures)

Unit- 4

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. (14 Lectures)

Reference 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.

SUGGESTED WEB SOURCES:

1. NPTEL :: Courses
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for OELC-401A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
OELC401A.1	3	-	2	2	2	3	-	1	2	-	-	-	-	-	1	3	3	-
OELC401A.2	3	-	2	2	2	3	-	3	2	-	-	-	-	-	1	3	3	-
OELC401A.3	3	2	3	3	3	3	2	2	3	2	2	-	2	2	1	3	3	-
OELC401A.4	3	-	2	2	2	3	-	3	2	-	-	-	-	-	1	3	3	-
OELC401A.5	3	2	3	3	3	3	2	3	3	2	2	-	2	2	1	3	3	-
OELC401A.6	3	2	3	3	3	3	2	3	3	2	2	-	2	2	1	3	3	-

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER IV
CODE: OELC-402A
SUBJECT NAME: MICROPROCESSOR AND MICROCONTROLLER SYSTEM LAB
NO. OF CREDITS: 2

			SESSIONAL	: 15
L	T	P	FINAL EXAM	: 35
0	0	4	TOTAL	: 50

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

OELC402A.1 *Learn the basics of Microprocessor 8085.*
OELC402A.2 *Explore the basic algebraic operations using 8085 microprocessor.*
OELC402A.3 *Understand the programming using Microprocessor.*
OELC402A.4 *Verify the truth table of logic gates.*
OELC402A.5 *Understand the interfacing of integrated circuit 8255.*
OELC402A.6 *Generate terms of Fibonacci series using 8085 microprocessor.*
OELC402A.7 *Program for multi-byte addition and subtraction using microprocessor 8085.*
OELC402A.8 *Learn to transfer a block of data using 8085 microprocessor.*

At least 6 experiments from the following:

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.

Reference 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.

SUGGESTED WEB SOURCES:

1. Virtual Labs (vlab.co.in)

MODE OF TRANSACTION: Demonstration, E-tutoring, discussion; **LMS/ICT Tools:** Online Resources.

Mapping of CO and PO for OELC-402A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
OELC402A.1	3	2	3	3	3	3	3	2	1	3	3	-	3	3	3	3	3	3
OELC402A.2	3	2	3	3	3	3	3	1	1	3	3	-	3	3	3	3	3	3
OELC402A.3	3	2	3	3	3	3	3	2	1	3	3	-	3	3	3	3	3	3
OELC402A.4	3	2	3	3	3	3	3	3	1	3	3	-	3	3	3	3	3	3
OELC402A.5	3	2	3	3	3	3	3	2	1	3	3	-	3	3	3	3	3	3
OELC402A.6	3	2	3	3	3	3	3	3	1	3	3	-	3	3	3	3	3	3
OELC402A.7	3	2	3	3	3	3	3	3	1	3	3	-	3	3	3	3	3	3
OELC402A.8	3	2	3	3	3	3	3	3	1	3	3	-	3	3	3	3	3	3

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER IV
CODE: OCHE-401A
SUBJECT NAME: SPECTROSCOPY
NO. OF CREDITS: 4

L	T	P
4	0	0

SESSIONAL	: 25
FINAL EXAM	: 75
TOTAL	: 100

NOTE: Question paper will have two parts. Part-A is compulsory and contains 10 questions each of 1.5 marks covering the entire syllabus. Part-B has 6 questions each of 15 marks and students are required to attempt any four questions from this part.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

OCHE401A.1	*Learn the basics of spectroscopy, rotational spectrum and vibrational spectrum.*
OCHE401A.2	*Understand the principle and working of various spectroscopy techniques.*
OCHE401A.3	*Examine the effect of electronic transitions, conjugation and functional groups on the spectrum.*
OCHE401A.4	*Predict energy levels of rigid rotator using rotational spectrum.*
OCHE401A.5	*Examine pure rotational and pure vibrational Raman spectra of diatomic molecules.*
OCHE401A.6	*Apply the spectroscopy techniques to elucidate simple organic compounds.*

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. (12 Lectures)

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 λ_{max} of simple conjugated dienes and unsaturated ketones. Applications of UV Spectroscopy in structure elucidation of simple. (12 Lectures)

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. (12 Lectures)

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.

(12 Lectures)

Reference Books:

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.

SUGGESTED WEB SOURCES:

1. NPTEL :: Courses
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for OCHE-401A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
OCHE401A.1	3	1	3	3	3	3	1	3	1	2	2	-	2	2	1	2	2	-
OCHE401A.2	3	2	3	3	3	3	2	3	1	2	2	-	2	2	1	2	2	-
OCHE401A.3	3	2	2	3	3	3	2	3	1	2	1	-	2	2	1	2	1	-
OCHE401A.4	3	2	2	3	3	3	2	3	1	2	1	-	2	2	1	2	1	-
OCHE401A.5	3	2	3	3	3	3	2	3	1	2	2	-	2	2	1	2	2	-
OCHE401A.6	3	2	3	3	3	3	2	3	1	2	2	-	2	2	1	2	2	-

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER IV
CODE: OCHE-402A
SUBJECT NAME: SPECTROSCOPY LAB
NO. OF CREDITS: 2

L	T	P		
			SESSIONAL	: 15
0	0	4	FINAL EXAM	: 35
			TOTAL	: 50

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

OCHE402A.1	*Observe the spectrum of simple organic compounds.*
OCHE402A.2	*Learn practical approach to structural elucidation of organic compounds with specific examples.*
OCHE402A.3	*Interpret various types of spectra in structure elucidation.*
OCHE402A.4	*Examine the pH-dependence of the UV-Vis spectrum of $K_2Cr_2O_7$.*
OCHE402A.5	*Analyze qualitatively organic compounds containing mono-functional groups.*
OCHE402A.6	*Verify Lambert-Beer's law.*
OCHE402A.7	*Determine the concentrations in a mixture using Lambert-Beer's law.*
OCHE402A.8	*Apply the spectroscopy techniques to elucidate simple organic compounds.*

1. Verify Lambert-Beer's law and determine the concentration of CuSO4/KMnO4/K2Cr2O7 in a solution of unknown concentration II. Determine the concentrations of KMnO4 and K2Cr2O7 in a mixture.

2. Study the 200-500 nm absorbance spectra of KMnO4 and K2Cr2O7 (in 0.1 M H2SO4) and determine the λmax values. Calculate the energies of the two transitions in different units (J molecule-1 , kJ mol-1 , cm-1 , eV)

3. Study the pH-dependence of the UV-Vis spectrum (200-500 nm) of K2Cr2O7.

4. Record the 200-350 nm UV spectra of the given compounds (acetone, acetaldehyde, 2-propanol, acetic acid) in water. Comment on the effect of structure on the UV spectra of organic compounds.

5. Identification of simple organic compounds by IR spectroscopy and NMR spectroscopy (Spectra to be provided).

6. Qualitative analysis of unknown organic compounds containing monofunctional groups (carbohydrates, aryl halides, aromatic hydrocarbons, nitro compounds, amines and amides)

Reference Books:

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. Spectroscopic Methods in Organic Chemistry, D. H. Williams and I. Fleming, Tata McGraw-Hill.
4. Spectroscopy of Organic Compounds by P.S. Kalsi, Wiley Estern, New Delhi.
5. Organic Spectroscopy by William Kemp, John Wiley.

SUGGESTED WEB SOURCES:

1. Virtual Labs (vlab.co.in)

MODE OF TRANSACTION: Demonstration, E-tutoring, discussion; **LMS/ICT Tools:** Online Resources.

Mapping of CO and PO for OCHE-402A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
OCHE402A.1	3	2	3	3	3	3	2	3	1	-	2	2	2	1	2	2	2	2
OCHE402A.2	3	2	3	3	3	3	2	3	1	-	2	2	2	1	2	2	2	2
OCHE402A.3	3	2	3	3	3	3	2	3	1	-	2	2	2	1	2	2	2	2
OCHE402A.4	3	2	3	3	3	3	2	3	1	-	2	2	2	1	2	2	2	2
OCHE402A.5	3	2	3	3	3	3	2	3	1	-	2	2	2	1	2	2	2	2
OCHE402A.6	3	2	3	3	3	3	2	3	1	-	2	2	2	1	2	2	2	2
OCHE402A.7	3	2	3	3	3	3	2	3	1	-	2	2	2	1	2	2	2	2
OCHE402A.8	3	2	3	3	3	3	2	3	1	-	2	2	2	1	2	2	2	2

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER IV
CODE: OCSC-401A
SUBJECT NAME: INFORMATION SECURITY
NO. OF CREDITS: 4

L	T	P		
			SESSIONAL	: 25
			FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-A is compulsory and contains 10 questions each of 1.5 marks covering the entire syllabus. Part-B has 6 questions each of 15 marks and students are required to attempt any four questions from this part.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

OCSC401A.1	*Understand theory of fundamental cryptography, encryption and decryption algorithms.*
OCSC401A.2	*Build secure authentication systems by use of message authentication techniques.*
OCSC401A.3	*Understand a given ciphering algorithm and to analyze it.*
OCSC401A.4	*Examine the SSL or firewall based solution against security threats*
OCSC401A.5	*Learn ethical issues related to the misuse of computer security.*
OCSC401A.6	*Apply the crypto systems so far learned to building of information and network security mechanisms.*

UNIT-I
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.
(12 Lectures)

UNIT-II
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. (12 Lectures)

UNIT-III
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. (14 Lectures)

Safety Tools and Issues : Firewalls, logging and intrusion detection systems, Windows and windows XP / NT security, Unix/Linux security, ethics of hacking and cracking.
(10 Lectures)

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.

SUGGESTED WEB SOURCES:

1. NPTEL :: Courses
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for OCSE-401A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
OCSE401A.1	3	2	3	3	3	3	2	3	2	3	2	2	2	2	3	2	2	-
OCSE401A.2	3	2	3	3	3	3	2	3	2	3	2	2	2	2	3	2	2	-
OCSE401A.3	3	2	3	3	3	3	2	3	2	3	2	2	2	2	3	2	2	-
OCSE401A.4	3	2	3	3	3	3	2	3	2	3	2	2	2	2	3	2	2	-
OCSE401A.5	3	2	3	3	3	3	2	3	2	3	2	2	2	2	3	2	2	-
OCSE401A.6	3	2	3	3	3	3	2	3	2	3	2	2	2	2	3	2	2	-

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER IV
CODE: OCSC-402A
SUBJECT NAME: INFORMATION SECURITY LAB
NO. OF CREDITS: 2

L	T	P		
			SESSIONAL	: 15
			FINAL EXAM	: 35
0	0	4	TOTAL	: 50

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

OCSC402A.1	*Demonstrate the use of Network tools.*
OCSC402A.2	*Perform encryption and decryption of Caesar cipher and Rail fence cipher.*
OCSC402A.3	*Analyze a remote machine using nmap/zenmap.*
OCSC402A.4	*Capture and modify a message using Burp proxy.*
OCSC402A.5	*Demonstrate sending of protected and digitally signed documents.*
OCSC402A.6	*Learn use of steganography tools.*
OCSC402A.7	*Write script for encryption and decryption of Caesar cipher and Rail fence cipher.*
OCSC402A.8	*Use gpg utility for signing and encrypting purposes.*

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.
4. Perform encryption and decryption of Caesar cipher. Write a script for performing these operations.
5. Perform encryption and decryption of a Rail fence cipher. Write a script for performing these operations.
6. Use nmap/zenmap to analyse a remote machine.
7. Use Burp proxy to capture and modify the message.
8. Demonstrate sending of a protected word document.
9. Demonstrate sending of a digitally signed document.
10. Demonstrate sending of a protected worksheet.
11. Demonstrate use of steganography tools.
12. Demonstrate use of gpg utility for signing and encrypting purposes

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.

SUGGESTED WEB SOURCES:

1. [Virtual Labs (vlab.co.in)]

MODE OF TRANSACTION: Demonstration, E-tutoring, discussion; **LMS/ICT Tools:** Online Resources.

Mapping of CO and PO for OCSE-402A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
OCSE402A.1	3	2	3	3	3	3	2	2	-	3	2	2	2	2	2	2	1	-
OCSE402A.2	3	2	3	3	3	3	2	2	-	3	2	2	2	2	2	2	2	-
OCSE402A.3	3	2	3	3	3	3	2	2	-	3	2	2	2	2	2	2	2	-
OCSE402A.4	3	2	3	3	3	3	2	2	-	3	2	2	2	2	2	2	2	-
OCSE402A.5	3	2	3	3	3	3	2	2	-	3	2	2	2	2	2	2	2	-
OCSE402A.6	3	2	3	3	3	3	2	2	-	3	2	2	2	2	2	2	2	-
OCSE402A.7	3	2	3	3	3	3	2	2	-	3	2	2	2	2	2	2	2	-
OCSE402A.8	3	2	3	3	3	3	2	2	-	3	2	2	2	2	2	2	2	-

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

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 SEMESTER III&IV
CODE: SECP-01A
SUBJECT NAME: COMPUTATIONAL PHYSICS SKILLS
NO. OF CREDITS: 2

			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
2	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-A is compulsory and contains 10 questions each of 1.5 marks covering the entire syllabus. Part-B has 6 questions each of 15 marks and students are required to attempt any four questions from this part.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

SECP01A.1 *Learn the basics of algorithms and flowcharts of FORTRAN programming language.*

SECP01A.2 *Understand the concepts of scientific programming in FORTRAN for the analysis of various scientific and engineering problems.*

SECP01A.3 *Examine the control statements in FORTRAN and solve physics problems using them.*

SECP01A.4 *Understand plotting in simple physics problems using Gnuplot.*

SECP01A.5 *Investigate graphically a set of data using Gnuplot along with identifying its limitations and applications.*

SECP01A.6 *Explore computational skills of numerical modelling and simulation using FORTRAN.*

Course will consist of hands-on training on Problem solving on Computers.

Unit-I

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. (6 Lectures)

Unit-II

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. (9 Lectures)

Unit-III

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. (9 Lectures)

Unit-IV

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)

Reference Books:

1. Introduction to Numerical Analysis, S.S. Sastry, 5th Edn., 2012, PHI Learning Pvt. Ltd.
2. Computer Programming in Fortran 77”. V. Rajaraman (Publisher:PHI).
3. Gnuplot in action: understanding data with graphs, Philip K Janert, (Manning 2010)
4. Schaum’s Outline of Theory and Problems of Programming with Fortran, S Lipsdutz and A Poe, 1986Mc-Graw Hill Book Co.
5. Computational Physics: An Introduction, R. C. Verma, etal. New Age International Publishers, New Delhi(1999)
6. Elementary Numerical Analysis, K.E.Atkinson,3rd Edn . , 2 007 , Wiley India Edition.

SUGGESTED WEB SOURCES:

1. NPTEL :: Courses
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for SECP-01A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
SECP01A.1	3	1	2	1	1	1	2	2	1	3	2	-	2	2	2	3	3	3
SECP01A.2	3	2	3	3	3	3	2	2	1	3	2	-	2	2	2	3	3	3
SECP01A.3	3	1	3	3	3	3	2	3	2	3	3	-	3	2	2	3	3	3
SECP01A.4	3	2	3	3	3	3	2	2	1	3	2	-	2	2	2	3	3	3
SECP01A.5	3	1	3	3	3	3	2	3	2	3	3	-	3	2	2	3	3	3
SECP01A.6	3	2	3	3	3	3	2	3	2	3	3	-	3	2	2	3	3	3

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER III&IV
CODE: SECP-02A
SUBJECT NAME: ELECTRICAL CIRCUITS AND NETWORK SKILLS
NO. OF CREDITS: 2

L	T	P		
			SESSIONAL	: 25
			FINAL EXAM	: 75
2	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-A is compulsory and contains 10 questions each of 1.5 marks covering the entire syllabus. Part-B has 6 questions each of 15 marks and students are required to attempt any four questions from this part.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

SECP02A.1 *Learn basics of electrical circuits and their working principles.*

SECP02A.2 *Understand working theory of Generators/Transformers and AC and DC motors.*

SECP02A.3 *Learn the various passive components and their connections.*

SECP02A.4 *Examine electrical wiring and explore electrical protection techniques.*

SECP02A.5 *Analyze alternating current sourced electrical circuits.*

SECP02A.6 *Understand resistors, inductors and capacitors.*

UNIT-I
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. (5 Lectures)

UNIT-II
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. (8 Lectures)

UNIT-III
Generators and Transformers: DC Power sources. AC/DC generators. Inductance, capacitance, and impedance. Operation of transformers.
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.
Solid-State Devices: Resistors, inductors and capacitors. Components in Series or in shunt. Response of inductors and capacitors with DC or AC sources. (9 Lectures)

UNIT-IV

Electrical Protection: Relays. Fuses and disconnect switches. Circuit breakers. Overload devices. Ground-fault protection. Grounding and isolating. Phase reversal. Surge protection. Relay protection device.

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.

(8 Lectures)

Reference Books:

1. 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.
2. A text book of Electrical Technology - A K Theraja
3. Performance and design of AC machines - M G Say ELBS Edn.

SUGGESTED WEB SOURCES:

1. NPTEL :: Courses
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for SECP-02A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
SECP02A.1	3	2	3	3	3	3	2	3	2	3	3	-	3	2	2	3	3	3
SECP02A.2	3	2	3	3	3	3	2	3	2	3	3	-	3	2	2	3	3	3
SECP02A.3	3	2	3	3	3	3	2	3	2	3	3	-	3	2	2	3	3	3
SECP02A.4	3	2	3	3	3	3	2	3	2	3	3	-	3	2	2	3	3	3
SECP02A.5	3	2	3	3	3	3	2	3	2	3	3	-	3	2	2	3	3	3
SECP02A.6	3	2	3	3	3	3	2	3	2	3	3	-	3	2	2	3	3	3

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER III&IV
CODE: SECP-03A
SUBJECT NAME: BASIC INSTRUMENTATION SKILLS
NO. OF CREDITS: 2

L	T	P		
			SESSIONAL	: 25
			FINAL EXAM	: 75
2	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-A is compulsory and contains 10 questions each of 1.5 marks covering the entire syllabus. Part-B has 6 questions each of 15 marks and students are required to attempt any four questions from this part.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

SECP03A.1 *Learn the necessary working knowledge on accuracy, precision, resolution, range and errors/uncertainty in measurements.*

SECP03A.2 *Gain knowledge on the working and operations of multimeter.*

SECP03A.3 *Understand about digital instruments like voltmeter and milivoltmeter.*

SECP03A.4 *Understand the working, theory and applications of CRO for measurements.*

SECP03A.5 *Understand the concept of impedance bridges and Q-meters.*

SECP03A.6 *Learn about the block diagram and working of a digital meter and its various associated parameters.*

UNIT-I

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)

UNIT-II

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)

UNIT-III

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. Use 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. (10 Lectures)

UNIT-IV

Impedance Bridges and Q-meters: 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.

Digital Instruments: Comparison of analog & digital instruments. Characteristics of a digital meter. Working principles and block diagram of digital voltmeter. Principle of time interval, frequency and period measurement using universal counter/ frequency counter, time- base stability, accuracy and resolution. (10 Lectures)

Reference Books:

1. A text book in Electrical Technology - B L Theraja - S Chand and Co. Performance and design of AC machines - M G Say ELBS Edn.
2. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill. Logic circuit design, Shimon P. Vingron, 2012, Springer.
3. Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
4. Electronic Devices and circuits, S. Salivahanan & N. S.Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill

SUGGESTED WEB SOURCES:

1. NPTEL :: Courses
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for SECP-03A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
SECP03A.1	3	1	3	3	1	3	-	2	-	-	-	-	-	-	2	3	3	3
SECP03A.2	3	-	3	3	1	2	-	2	1	2	1	-	-	-	1	3	3	3
SECP03A.3	3	-	2	2	2	2	-	2	1	1	-	-	-	-	1	3	3	3
SECP03A.4	3	-	2	1	1	1	-	1	1	2	-	-	-	-	0	3	3	3
SECP03A.5	3	-	2	2	-	1	-	1	-	-	-	-	-	-	1	3	3	3
SECP03A.6	3	-	1	2	2	2	-	2	2	1	-	-	-	-	2	3	3	3

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER III&IV
CODE: SECP-04A
SUBJECT NAME: COMPUTATIONAL PHYSICS SKILLS LAB
NO. OF CREDITS: 0

L	T	P		
			SESSIONAL	: 15
			FINAL EXAM	: 35
0	0	2	TOTAL	: 50

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

SECP04A.1 *Use the basics of algorithms and flowcharts of FORTRAN programming language.*

SECP04A.2 *Perform computationally the various commands of FORTRAN programming language.*

SECP04A.3 *Solve computationally simple algebraic equations using FORTRAN.*

SECP04A.4 *Compile a frequency distribution and evaluate mean, standard deviation for a given set of experimental data.*

SECP04A.5 *Determine sum of finite series, area under a curve, matrix algebra and Fibonacci series using FORTRAN.*

SECP04A.6 *Examine equations of motion of a simple harmonic oscillator using FORTRAN and plot the output using Gnuplot.*

SECP04A.7 *Simulate projectile motion and motion of a particle in a central field using FORTRAN and visualize the output using Gnuplot.*

SECP04A.8 *Explore computational skills of numerical modelling and simulation using FORTRAN.*

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:

1. Introduction to Numerical Analysis, S.S. Sastry, 5th Edn., 2012, PHI Learning Pvt. Ltd.
2. Computer Programming in Fortran 77". V. Rajaraman (Publisher:PHI).
3. Gnuplot in action: understanding data with graphs, Philip K Janert, (Manning 2010)
4. Schaum's Outline of Theory and Problems of Programming with Fortran, S Lipsdutz and A Poe, 1986Mc-Graw Hill Book Co.
5. Computational Physics: An Introduction, R. C. Verma, etal. New Age International Publishers, New Delhi(1999)
6. Elementary Numerical Analysis, K.E.Atkinson,3 rd Edn . , 2 007 , Wiley India Edition.

SUGGESTED WEB SOURCES:

1. Virtual Labs (vlab.co.in)

MODE OF TRANSACTION: Demonstration, E-tutoring, discussion; **LMS/ICT Tools:** Online Resources.

Mapping of CO and PO for SECP-04A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
SECP04A.1	3	2	2	2	3	3	3	3	1	3	3	-	2	2	2	3	3	3
SECP04A.2	3	2	3	3	3	3	3	3	1	3	3	-	3	3	2	3	3	3
SECP04A.3	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	3
SECP04A.4	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	3
SECP04A.5	3	2	3	3	3	3	3	2	1	3	3	-	2	2	2	3	3	3
SECP04A.6	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	3
SECP04A.7	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	3
SECP04A.8	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	3

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER III&IV
CODE: SECP-05A
SUBJECT NAME: ELECTRICAL CIRCUITS AND NETWORK SKILLS LAB
NO. OF CREDITS: 0

L	T	P		
			SESSIONAL	: 15
			FINAL EXAM	: 35
0	0	2	TOTAL	: 50

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

SECP05A.1 *Understand the use of multimeter to measure AC and DC Voltage and Current, Resistance, and Power.*

SECP05A.2 *Examine series, parallel, and series-parallel combinations.*

SECP05A.3 *Verify Ohm's law using series, parallel, and series-parallel combinations.*

SECP05A.4 *Understand the working of DC Power sources, AC/DC generators, Inductance, capacitance, impedance and operation of transformers.*

SECP05A.5 *Understand the basics of Resistors, inductors and capacitors. Diode, rectifiers and filters.*

SECP05A.6 *Analyze response of inductors and capacitors with DC or AC sources.*

SECP05A.7 *Understand the basics of wiring-Star and delta connection.*

SECP05A.8 *Design extension board.*

At least 6 experiments from the following:

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:

1. Electrical Circuits, K.A. Smith and R.E. Alley, 2014, Cambridge University Press
2. A text book in Electrical Technology - B L Theraja - S Chand & Co.
3. A text book of Electrical Technology - A K Theraja
4. Performance and design of AC machines - M G Say ELBS Edn.

SUGGESTED WEB SOURCES:

1. Virtual Labs (vlab.co.in)

MODE OF TRANSACTION: Demonstration, E-tutoring, discussion; **LMS/ICT Tools:** Online Resources.

Mapping of CO and PO for SECP-05A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
SECP05A.1	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	3
SECP05A.2	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	3
SECP05A.3	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	3
SECP05A.4	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	3
SECP05A.5	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	3
SECP05A.6	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	3
SECP05A.7	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	3
SECP05A.8	3	2	3	3	3	3	3	3	2	3	3	-	3	3	2	3	3	3

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER III&IV
CODE: SECP-06A
SUBJECT NAME: BASIC INSTRUMENTATION SKILLS LAB
NO. OF CREDITS: 0

L	T	P		
			SESSIONAL	: 15
			FINAL EXAM	: 35
0	0	2	TOTAL	: 50

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

SECP06A.1 *Learn the loading effect of a multimeter while measuring voltage across a low resistance and high resistance.*

SECP06A.2 *Measure Q of a coil and its dependence on frequency, using a Q- meter.*

SECP06A.3 *Observe waveforms on the C.R.O. and to measure amplitude and frequency of the waveforms.*

SECP06A.4 *Study variation in current and voltage in a series and parallel LCR.*

SECP06A.5 *Measurement of R, L and C using a LCR bridge.*

SECP06A.6 *Understand distortion of a RF signal generator using distortion factor meter.*

SECP06A.7 *Measurement of time period, frequency, average period using universal counter.*

SECP06A.8 *Observe the limitations of a multimeter for measuring high frequency voltage and currents.*

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. To observe sine wave, square wave, triangular wave and ramp waveforms on the C.R.O. and to measure amplitude and frequency of the waveforms .
5. Measurement of time period, frequency, average period using universal counter/ frequency counter.
6. Measurement of rise, fall and delay times using an 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.
9. To study the variation in current and voltage in a series LCR circuit and hence determine the resonant frequency of the circuit
10. To study the variation in current and voltage in a parallel LCR circuit and hence determine the resonant frequency of the circuit
11. To study the effect of voltmeter resistance on voltage measurement.

Reference Books:

1. A text book in Electrical Technology - B L Theraja - S Chand and Co. Performance and design of AC machines - M G Say ELBS Edn.
2. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill. Logic circuit design, Shimon P. Vingron, 2012, Springer.
3. Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
4. Electronic Devices and circuits, S. Salivahanan & N. S.Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill

SUGGESTED WEB SOURCES:

1. Virtual Labs (vlab.co.in)

MODE OF TRANSACTION: Demonstration, E-tutoring, discussion; **LMS/ICT Tools:** Online Resources.

Mapping of CO and PO for SECP-06A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
SECP06A.1	3	-	3	2	2	1	3	-	-	1	-	-	-	-	2	3	3	3
SECP06A.2	3	-	3	3	1	2	3	-	-	1	-	-	-	-	1	3	3	3
SECP06A.3	3	-	2	2	2	3	2	-	-	1	-	-	-	-	2	3	3	3
SECP06A.4	3	-	3	3	1	3	3	-	-	1	-	-	-	-	2	3	3	3
SECP06A.5	3	-	2	3	1	2	3	-	-	1	-	-	-	-	-	3	3	3
SECP06A.6	3	-	3	2	2	1	3	-	-	1	-	-	-	-	-	3	3	3
SECP06A.7	3	-	3	2	1	-	2	-	-	1	-	-	-	-	-	3	3	3
SECP06A.8	3	-	3	1	2	-	3	-	-	1	-	-	-	-	-	3	3	3

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER III&IV
CODE: SECP-07A
SUBJECT NAME: RENEWABLE ENERGY AND ENERGY HARVESTING
NO. OF CREDITS: 2

L	T	P		
			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
2	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-A is compulsory and contains 10 questions each of 1.5 marks covering the entire syllabus. Part-B has 6 questions each of 15 marks and students are required to attempt any four questions from this part.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

SECP07A.1 Learn the fundamentals of renewable and other alternate energy sources.

SECP07A.2 Understand the principles of solar energy and its environmental impact.

SECP07A.3 Learn the basics of solar energy collection and storage.

SECP07A.4 Learn the basics and advances in Piezoelectric and hydroelectric energy.

SECP07A.5 Study the basics of wind energy and biomass energy.

SECP07A.6 Comprehend the use of renewable energy for various demands.

Unit-I

Introduction: Renewable energy and energy harvesting, Alternate Sources of energy and their limitations, Need of renewable energy, Non-conventional energy sources and their advantages.

Solar energy: Solar energy, its importance, storage of solar energy, applications of solar energy, solar water heater, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems. **(8 Lectures)**

Unit-II

Piezoelectric Energy harvesting: Introduction, Physics and characteristics of piezoelectric effect, materials and mathematical description of piezoelectricity, Piezoelectric parameters and modeling piezoelectric generators, Piezoelectric Energy harvesting applications, Human power.

Hydroelectric Energy Harvesting: Principal of water splitting, Working and fabrication of Hydroelectric Cell. Merits of green energy production through water splitting. Applications.

(8 Lectures)

Unit-III

Wind Energy harvesting: Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies.

Biomass Energy harvesting: Harvesting of biomass, Biomass conversion technologies, **T**hermo chemical and biochemical processes; reaction kinetics; energy and mass balance equations; studies of processes and system design for gasification, pyrolysis and liquefaction of biomass.

(8 Lectures)

UNIT-IV

Fossil fuels and Alternate Sources of energy: Fossil fuels and nuclear energy, their limitation, need of renewable energy, non-conventional energy sources. An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion. **(6 Lectures)**

Reference Books:

1. Non-conventional energy sources - G.D Rai - Khanna Publishers, New Delhi
2. Solar energy - M P Agarwal - S Chand and Co. Ltd.
3. Solar energy - Suhas P Sukhative Tata McGraw - Hill Publishing Company Ltd.
4. Godfrey Boyle, “Renewable Energy, Power for a sustainable future”, 2004, Oxford University Press, in association with The Open University.
5. Dr. P Jayakumar, Solar Energy: Resource Assesment Handbook, 2009.
6. J.Balfour, M.Shaw and S. Jarosek, Photovoltaics, Lawrence J Goodrich (USA).
7. http://en.wikipedia.org/wiki/Renewable_energy

SUGGESTED WEB SOURCES:

1. NPTEL :: Courses
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for SECP-07A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
SECP07A.1	3	2	3	3	3	3	3	3	1	3	3	1	2	2	3	3	3	3
SECP07A.2	3	2	3	3	3	3	3	3	1	3	3	1	2	2	3	3	3	3
SECP07A.3	3	2	3	3	3	3	3	3	1	3	3	1	2	2	3	3	3	3
SECP07A.4	3	2	3	3	3	3	3	3	1	3	3	1	2	2	3	3	3	3
SECP07A.5	3	2	3	3	3	3	3	3	1	3	3	1	2	2	3	3	3	3
SECP07A.6	3	2	3	3	3	3	3	3	1	3	3	1	2	2	3	3	3	3

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER III&IV
CODE: SECP-08A
SUBJECT NAME: RENEWABLE ENERGY AND ENERGY HARVESTING LAB
NO. OF CREDITS: 0

L	T	P		
			SESSIONAL	: 15
			FINAL EXAM	: 35
0	0	2	TOTAL	: 50

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

SECP08A.1 Learn the basics of renewable and other alternate energy sources.

SECP08A.2 Demonstrate the principles of solar energy and its environmental impact.

SECP08A.3 Understand the training modules of wind, ocean and geothermal energy.

SECP08A.4 Examine the working of Piezoelectric Energy Harvesting Devices.

SECP08A.5 Explore Electromagnetic Energy Harvesting Devices.

SECP08A.6 Analyze conversion of vibration to voltage using Piezoelectric Materials.

SECP08A.7 Analyze conversion of thermal energy to voltage using Thermoelectric Modules.

SECP08A.8 Comprehend the use of renewable energy for various demands

At least 6 experiments from the following:

1. Demonstration of Training modules on Solar energy.
2. Demonstration of Training modules on Wind energy.
3. Demonstration of Training modules on Ocean energy.
4. Demonstration of Training modules on Geothermal energy.
5. Demonstration of Piezoelectric Energy Harvesting Devices.
6. Demonstration of Electromagnetic Energy Harvesting Devices.
7. Conversion of Vibration to Voltage using Piezoelectric Materials.
8. Conversion of Thermal Energy into Voltage using Thermoelectric Modules.

Reference Books:

1. Non-conventional energy sources - G.D Rai - Khanna Publishers, New Delhi
2. Solar energy - M P Agarwal - S Chand and Co. Ltd.
3. Solar energy - Suhas P Sukhative Tata McGraw - Hill Publishing Company Ltd.
4. Godfrey Boyle, "Renewable Energy, Power for a sustainable future", 2004, Oxford University Press, in association with The Open University.

SUGGESTED WEB SOURCES:

1. Virtual Labs (vlab.co.in)

MODE OF TRANSACTION: Demonstration, E-tutoring, discussion; **LMS/ICT Tools:** Online Resources.

Mapping of CO and PO for SECP-08A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
SECP08A.1	3	2	3	3	3	3	3	3	2	3	3	2	2	2	3	3	3	3
SECP08A.2	3	2	3	3	3	3	3	3	2	3	3	2	2	2	3	3	3	3
SECP08A.3	3	2	3	3	3	3	3	3	2	3	3	2	2	2	3	3	3	3
SECP08A.4	3	2	3	3	3	3	3	3	2	3	3	2	2	2	3	3	3	3
SECP08A.5	3	2	3	3	3	3	3	3	2	3	3	2	2	2	3	3	3	3
SECP08A.6	3	2	3	3	3	3	3	3	2	3	3	2	2	2	3	3	3	3
SECP08A.7	3	2	3	3	3	3	3	3	2	3	3	2	2	2	3	3	3	3
SECP08A.8	3	2	3	3	3	3	3	3	2	3	3	2	2	2	3	3	3	3

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

Syllabus of B.Sc. (H) Physics

Semester V

Discipline Core Course (DCC)

B.Sc. (H) PHYSICS SEMESTER V
CODE: BPH-501A
SUBJECT NAME: QUANTUM MECHANICS AND APPLICATIONS
NO. OF CREDITS: 4

			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-A is compulsory and contains 10 questions each of 1.5 marks covering the entire syllabus. Part-B has 6 questions each of 15 marks and students are required to attempt any four questions from this part.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

BPH501A.1 *Interpret the wave function of a quantum particle and probabilistic nature of its location and subtler points of quantum phenomena.*

BPH501A.2 *Describe the quantum mechanical operators of position, momentum and energy and solve the commutation brackets of these.*

BPH501A.3 *Explain the time independent schrodinger equation, its solution and apply the same on problems like Gaussian wave packet.*

BPH501A.4 *Understand the behavior of quantum particle encountering a i) one dimensional square well potential, ii) potential barrier iii) simple harmonic oscillation.*

BPH501A.5 *Solve Schrodinger equation for radial wavefunction of non-relativistic hydrogen atom, for its spectrum and eigenfunctions.*

BPH501A.6 *Illustrate the theory of Angular Momentum and its application in quantum mechanics.*

Unit-I

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. (12 Lectures)

Unit-II

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. (12 Lectures)

Unit-III

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. (12 Lectures)

Unit-IV

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. (12 Lectures)

Reference Books:

1. A Text book of Quantum Mechanics, P.M.Mathews and K.Venkatesan, 2nd Ed., 2010, McGraw Hill
2. Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn., 2002, Wiley.
3. Quantum Mechanics, Leonard I. Schiff, 3rd Edn. 2010, Tata McGraw Hill.
4. Quantum Mechanics for Scientists & Engineers, D.A.B. Miller, 2008, Cambridge University Press
5. Quantum Mechanics, Eugen Merzbacher, 2004, John Wiley and Sons, Inc.
6. Introduction to Quantum Mechanics, D.J. Griffith, 2nd Ed. 2005, Pearson Education

SUGGESTED WEB SOURCES:

1. NPTEL :: Courses
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for BPH-501A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
BPH501A.1	3	3	3	3	3	2	2	3	2	3	3	-	2	-	3	3	3	1
BPH501A.2	3	3	3	3	3	1	2	3	3	3	3	-	3	-	3	3	3	1
BPH501A.3	3	3	3	3	3	2	2	3	2	2	2	-	2	-	3	3	2	1
BPH501A.4	3	3	3	3	3	2	3	3	3	2	2	-	2	-	3	3	3	1
BPH501A.5	3	3	3	3	3	1	2	3	2	2	2	-	2	-	3	3	3	1
BPH501A.6	3	3	3	3	3	1	2	3	3	2	3	-	3	-	3	3	3	2

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER V
CODE: BPH-502A
SUBJECT NAME: SOLID STATE PHYSICS
NO. OF CREDITS: 4

L	T	P		
			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-A is compulsory and contains 10 questions each of 1.5 marks covering the entire syllabus. Part-B has 6 questions each of 15 marks and students are required to attempt any four questions from this part.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

BPH502A.1 *Understand the crystal structure of different materials and lattice dynamics.*

BPH502A.2 *Interpret the X ray diffraction pattern of unknown materials.*

BPH502A.3 *Explain the concept of phonons and lattice vibrations.*

BPH502A.4 *Understand the origin of bands in solids.*

BPH502A.5 *Understand the properties of dielectric and ferroelectric materials.*

BPH502A.6 *Describe the concept of superconductivity.*

Unit-I

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.
Diffraction of X-rays by Crystals. Bragg"s Law. Laue conditions. Atomic and Scattering Factor SC, BCC, FCC, NaCl, ZnS, Diamond. (12 Lectures)

Unit-II

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.
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.
(12 Lectures)

Unit-III

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.

Dielectric Properties of Materials: Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius Mosotti Equation.

(12 Lectures)

Unit-IV

Ferroelectric Properties of Materials: Classification of crystals, Piezoelectric effect, Pyroelectric effect, Ferroelectric effect, Electrostrictive effect, Curie-Weiss Law, Ferroelectric domains, PE hysteresis loop.

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) (12 Lectures)

Reference Books:

1. Introduction to Solid State Physics, Charles Kittel, 8th Edn., 2004, Wiley India Pvt. Ltd.
2. Elements of Solid State Physics, J.P. Srivastava, 2nd Edn., 2006, Prentice-Hall of India.
3. Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill.
4. Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning.
5. Solid-state Physics, H.Ibach and H. Luth, 2009, Springer.
6. Solid State Physics, Rita John, 2014, McGraw Hill
7. Solid State Physics, M.A. Wahab, 2011, Narosa Publications.

SUGGESTED WEB SOURCES:

1. NPTEL :: Courses
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for BPH-502A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
BPH502A.1	3	1	2	3	3	2	1	3	1	1	2	1	1	1	1	3	2	2
BPH502A.2	3	1	2	2	3	2	1	3	1	2	3	1	1	1	1	3	2	2
BPH502A.3	3	1	2	3	3	2	1	3	1	1	2	1	1	1	1	3	2	2
BPH502A.4	3	1	2	2	3	3	1	2	1	1	3	1	1	1	1	3	2	2
BPH502A.5	3	1	2	3	3	3	1	2	1	1	2	1	1	1	1	3	2	2
BPH502A.6	3	1	2	3	3	3	1	2	1	1	2	1	1	1	1	3	2	2

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER V
CODE: BPH-503A
SUBJECT NAME: QUANTUM MECHANICS AND APPLICATIONS LAB
NO. OF CREDITS: 2

L	T	P		
			SESSIONAL	: 15
			FINAL EXAM	: 35
0	0	4	TOTAL	: 50

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

BPH503A.1 *Demonstrate experiments using Scilab to appreciate nuances involved in the theory of quantum mechanics.*

BPH503A.2 *Verify the correctness of solution of Schrodinger wave equation for Hydrogen atom.*

BPH503A.3 *Determine the solution of the radial part of Schrodinger equation for two electron system.*

BPH503A.4 *Solve the s-wave radial Schrodinger equation for Harmonic and Anharmonic oscillators.*

BPH503A.5 *Expose the solution of s-wave radial Schrodinger equation for the vibrations of hydrogen molecules in Morse potential.*

BPH503A.6 *Perform computational programming for formulation of Pauli's spin matrices and their product.*

BPH503A.7 *Simulate ground state energy of normal He atom.*

BPH503A.8 *Explore computational skills via evaluating commutation brackets of position, energy and momentum operators*

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 of the hydrogen atom.
2. Solve the s-wave radial Schrodinger equation for the first excited state of the hydrogen atom.
3. Solve the s-wave radial Schrodinger equation for harmonic oscillator.
4. Solve the s-wave radial Schrodinger equation for anharmonic oscillator.
5. Solve the s-wave radial Schrodinger equation for the vibrations of hydrogen molecule.
6. Determine the angular momentum of Hydrogen like atoms.
7. Calculate the eigenvalues and eigenstates of simple harmonic oscillator.

8. Formulate Pauli's spin matrices and their products.
9. Estimate the ground state energy of two electron systems like He.
10. Evaluate the commutation brackets of position, energy and momentum operators.

Reference Books:

1. Schaum's outline of Programming with C++.J.Hubbard, 20 00, McGraw-Hill Publication
2. An introduction to computational Physics, T.Pang, 2nd Edn.,2006, Cambridge Univ. Press
3. Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific & Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández.2014 Springer.
4. Scilab (A Free Software to Matlab): H. Ramchandran, A.S. Nair. 2011 S. Chand & Co

SUGGESTED WEB SOURCES:

1. Virtual Labs (vlab.co.in)

MODE OF TRANSACTION: Demonstration, E-tutoring, discussion; **LMS/ICT Tools:** Online Resources.

Mapping of CO and PO for BPH-503A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
BPH503A.1	3	3	1	2	1	2	3	2	2	3	3	-	3	-	3	3	2	3
BPH503A.2	3	3	3	3	3	1	3	2	2	3	3	-	3	-	3	3	3	3
BPH503A.3	3	3	3	3	3	2	3	3	3	3	3	-	2	-	3	3	2	3
BPH503A.4	3	3	2	3	3	1	3	3	2	3	2	-	2	-	3	3	3	3
BPH503A.5	3	3	2	3	3	1	3	3	2	3	2	-	2	-	3	3	2	3
BPH503A.6	3	3	2	2	2	3	3	3	2	3	3	-	3	-	3	3	3	3
BPH503A.7	3	3	2	2	3	2	3	3	2	3	2	-	3	-	3	3	3	3
BPH503A.8	3	3	2	2	2	3	3	2	2	3	3	-	3	-	3	3	3	2

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER V
CODE: BPH-504A
SUBJECT NAME: SOLID STATE PHYSICS LAB
NO. OF CREDITS: 2

L	T	P		
			SESSIONAL	: 15
			FINAL EXAM	: 35
0	0	4	TOTAL	: 50

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

BPH504A.1 *Demonstrate experiments related to the dielectric properties of materials.*

BPH504A.2 *Verify the properties of magnetic materials like hysteresis in ferromagnetic materials.*

BPH504A.3 *Apply the knowledge of X ray diffraction and explore the different types of crystals.*

BPH504A.4 *Understand the properties of semiconductors using the experiments like hall effect and two probe methods.*

BPH504A.5 *Measure the Magnetic susceptibility of Solids.*

BPH504A.6 *Quantify the materials as magnetic, semiconductor, crystalline or amorphous.*

BPH504A.7 *Determine the Coupling Coefficient of a Piezoelectric crystal.*

BPH504A.8 *Examine change in resistance of a semiconductor with magnetic field.*

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:

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. A Text Book of Practical Physics, I.Prakash& Ramakrishna, 11th Ed., 2011, Kitab Mahal
3. Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India.

SUGGESTED WEB SOURCES:

1. [Virtual Labs (vlab.co.in)](vlab.co.in)

MODE OF TRANSACTION: Demonstration, E-tutoring, discussion; **LMS/ICT Tools:** Online Resources.

Mapping of CO and PO for BPH-504A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
BPH504A.1	3	1	2	3	3	2	1	3	1	1	2	1	1	1	1	3	2	2
BPH504A.2	3	1	2	2	3	2	1	3	1	2	3	1	1	1	1	3	2	2
BPH504A.3	3	1	2	3	3	2	1	3	1	1	2	1	1	1	1	3	2	2
BPH504A.4	3	1	2	2	3	3	1	2	1	1	3	1	1	1	1	3	2	2
BPH504A.5	3	1	2	3	3	3	1	2	1	1	2	1	1	1	1	3	2	2
BPH504A.6	3	1	2	3	3	3	1	2	1	1	2	1	1	1	1	3	2	2
BPH504A.7	3	1	2	3	3	3	1	2	1	1	2	1	1	1	1	3	2	2
BPH504A.8	3	1	2	3	3	3	1	2	1	1	2	1	1	1	1	3	2	2

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

Discipline Elective Course in Physics (DECP) Semester-V

Select any two papers and corresponding lab (if any)

B.Sc. (H) PHYSICS SEMESTER V
CODE: DECP-501A
SUBJECT NAME: ATOMIC AND MOLECULAR PHYSICS
NO. OF CREDITS: 6

L	T	P		
			SESSIONAL	: 25
			FINAL EXAM	: 75
5	1	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-A is compulsory and contains 10 questions each of 1.5 marks covering the entire syllabus. Part-B has 6 questions each of 15 marks and students are required to attempt any four questions from this part.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

DECP501A.1 *Understand the fundamental aspects of atomic Physics and X-ray spectra.*

DECP501A.2 *Understand the behavior of atoms in electric and magnetic fields.*

DECP501A.3 *Examine the construct of many electron atoms spectra.*

DECP501A.4 *Understand the rotational and vibrational spectra of molecular structure.*

DECP501A.5 *Learn the Raman effect for structure determination of molecules.*

DECP501A.6 *Learn the fundamentals of Lasing action and explore the applications of lasers.*

Unit-I
Basics of atomic theory, X-rays and Atomic spectra
Determination of e/m of the Electron, Thompson, Helical Focussing method. Thermionic Emission, Dussmann's equation; **X-rays :-** Ionizing Power, Bohr Atomic Model, Critical Potentials, X-rays-Spectra: Continuous and Characteristic X-rays, Moseley Law.
Electron Angular Momentum. Space Quantization. Electron Spin and Spin Angular Momentum. Larmor's Theorem. Spin Magnetic Moment. Stern-Gerlach Experiment. (12 Lectures)

Unit-II

Atomic spectra in the presence of external fields: Zeeman Effect: Electron Magnetic Moment and Magnetic Energy, Gyromagnetic Ratio and Bohr Magneton.

Normal and Anomalous Zeeman Effect. Paschen Back and Stark Effect (Qualitative Discussion only).

Many Electron Atomic Spectra: 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.). (18 Lectures)

Unit-IV

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)

Unit-V

Raman effect and Lasers

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.

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. (15 Lectures)

Reference 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.
8. Atomic and Molecular Physics by Raj Kumar.

SUGGESTED WEB SOURCES:

1. NPTEL :: Courses
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for DECP-501A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
DECP501A.1	3	3	3	3	3	3	2	3	2	2	2	-	3	-	2	2	2	2
DECP501A.2	3	3	3	3	3	3	2	3	2	3	3	-	2	-	2	2	2	3
DECP501A.3	3	3	3	3	3	3	2	3	2	3	2	-	3	-	2	2	3	3
DECP501A.4	3	3	3	3	3	3	3	3	2	2	2	-	2	-	2	2	3	2
DECP501A.5	3	3	3	3	3	3	3	3	2	2	2	-	2	-	3	3	2	2
DECP501A.6	3	3	3	3	3	3	2	3	2	2	2	-	2	-	2	2	3	2

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER V
CODE: DECP-502A
SUBJECT NAME: EXPERIMENTAL TECHNIQUES
NO. OF CREDITS: 4

L	T	P		
			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-A is compulsory and contains 10 questions each of 1.5 marks covering the entire syllabus. Part-B has 6 questions each of 15 marks and students are required to attempt any four questions from this part.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

DECP502A.1 Understand the basics of measurements and error analysis.

DECP502A.2 Learn the fundamentals of transducers and industrial instruments.

DECP502A.3 Examine the working of digital multimeter and impedance bridges.

DECP502A.4 Understand the theory and working of various vacuum systems.

DECP502A.5 Portray the sources of noise in measurement system.

DECP502A.6 Design sensors using transducers and industrial instrumentation.

Unit-I

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.

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

Shielding and Grounding: Methods of safety grounding. Energy coupling. Grounding. Shielding: Electrostatic shielding. Electromagnetic Interference. (12 Lectures)

Unit-II

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.

(16 Lectures)

Unit-III

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.

Impedance Bridges and Q-meter: Block diagram and working principles of RLC bridge. Q-meter and its working operation. Digital LCR bridge. (10 Lectures)

Unit-4

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). (10 Lectures)

Reference Books:

1. Experimental Methods for Engineers, J.P. Holman, McGraw Hill
2. Introduction to Measurements and Instrumentation, A.K. Ghosh, 3rd Edition, PHI Learning Pvt. Ltd.
3. Transducers and Instrumentation, D.V.S. Murty, 2nd Edition, PHI Learning Pvt. Ltd.
4. Instrumentation Devices and Systems, C.S.Rangan, G.R. Sarma, V.S.V. Mani, Tata McGraw Hill
5. Electronic circuits: Handbook of design & applications, U.Tietze, Ch.Schenk, Springer

SUGGESTED WEB SOURCES:

1. NPTEL :: Courses
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for DECP-502A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
DECP502A.1	3	1	3	3	3	3	1	3	1	2	2	-	1	1	2	3	3	2
DECP502A.2	3	1	3	3	3	3	1	3	1	2	2	-	1	1	2	3	3	2
DECP502A.3	3	1	3	3	3	3	2	3	2	2	3	-	2	2	3	3	3	3
DECP502A.4	3	1	3	3	3	3	1	3	1	2	2	-	1	1	2	3	3	2
DECP502A.5	3	1	3	3	3	3	2	3	2	2	3	-	2	2	3	3	3	3
DECP502A.6	3	1	3	3	3	3	2	3	2	2	3	-	2	2	3	3	3	3

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER V
CODE: DECP-503A
SUBJECT NAME: LINEAR ALGEBRA & TENSOR ANALYSIS
NO. OF CREDITS: 6

				SESSIONAL	: 25
L	T	P		FINAL EXAM	: 75
5	1	0		TOTAL	: 100

NOTE: Question paper will have two parts. Part-A is compulsory and contains 10 questions each of 1.5 marks covering the entire syllabus. Part-B has 6 questions each of 15 marks and students are required to attempt any four questions from this part.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

DECP503A.1 *Learn the basic properties of the linear vector space such as linear dependence and independence of vectors, change of basis, isomorphism and homomorphism, linear transformations and their representation by matrices.*

DECP503A.2 *Learn the basic properties of matrices, the different types of matrices and their correspondence to physical quantities, e.g, operators in quantum mechanics.*

DECP503A.3 *They should also learn how to find the eigen-values and eigenvectors of matrices.*

DECP503A.4 *Learn some basic properties and different types of tensors.*

DECP503A.5 *Understand the transformation properties of tensors under coordinate transformations.*

DECP503A.6 *Understand physical examples of tensors such as moment of inertia tensor, energy momentum tensor, stress tensor, strain tensor etc.*

UNIT-I

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)

UNIT-II

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.

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. (18 Lectures)

UNIT-III

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.

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. (18 lectures)

UNIT-IV

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)

Reference Books:

1. Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.
2. Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber and F.E.Harris,1970, Elsevier.
3. Modern Mathematical Methods for Physicists and Engineers, C.D. Cantrell, 2011, Cambridge University Press.
4. Introduction to Matrices & Linear Transformations, D.T. Finkbeiner, 1978, Dover Pub.
5. Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole.

SUGGESTED WEB SOURCES:

1. NPTEL :: Courses
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for DECP-503A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
DECP503A.1	3	-	3	3	2	-	-	-	2	1	-	-	-	-	1	3	2	-
DECP503A.2	3	-	3	3	2	-	-	-	3	2	-	-	-	-	1	3	2	-
DECP503A.3	3	-	3	2	3	-	-	-	2	1	-	-	-	-	1	3	2	-
DECP503A.4	3	-	3	3	2	-	-	-	3	-	-	-	-	-	-	3	2	-
DECP503A.5	3	-	3	3	3	-	-	-	2	1	-	-	-	-	-	3	2	-
DECP503A.6	3	-	3	2	2	-	-	-	3	1	-	-	-	-	-	3	2	-

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER V
CODE: DECP-504A
SUBJECT NAME: EXPERIMENTAL TECHNIQUES LAB
NO. OF CREDITS: 2

L	T	P		
			SESSIONAL	: 15
			FINAL EXAM	: 35
0	0	4	TOTAL	: 50

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

DECP504A.1 *Determine output characteristics of a linear variable differential transformer (LVDT).*

DECP504A.2 *Analyze the characteristics of a Thermostat and determine its parameters.*

DECP504A.3 *Calibrate Semiconductor type temperature sensor and Resistance Temperature Device (RTD).*

DECP504A.4 *Create vacuum in a small chamber using a mechanical (rotary) pump and measure the chamber pressure using a pressure gauge*

DECP504A.5 *Compare noise in cables of different types (co-axial, single shielded, double shielded, without shielding).*

DECP504A.6 *Design and analyze the Clippers and Clampers circuits using junction diode.*

DECP504A.7 *Measure Q of a coil and influence of frequency, using a Q-meter.*

DECP504A.8 *Plot and analyze the frequency response of a microphone.*

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 2m length, 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:

1. Electronic circuits: Handbook of design and applications, U.Tietze and C.Schenk, 2008, Springer
2. Basic Electronics:A text lab manual, P.B.Zbar, A.P.Malvino, M.A.Miller, 1990, Mc-Graw Hill
3. Measurement, Instrumentation and Experiment Design in Physics & Engineering, M.Sayer and A. Mansingh, 2005, PHI Learning.

SUGGESTED WEB SOURCES:

1. Virtual Labs (vlab.co.in)

MODE OF TRANSACTION: Demonstration, E-tutoring, discussion; **LMS/ICT Tools:** Online Resources.

Mapping of CO and PO for DECP-504A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
DECP504A.1	3	2	3	3	3	3	2	3	1	2	3	1	2	2	2	3	3	3
DECP504A.2	3	2	3	3	3	3	2	3	1	2	3	1	2	2	2	3	3	3
DECP504A.3	3	2	3	3	3	3	2	3	1	2	3	1	2	2	2	3	3	3
DECP504A.4	3	2	3	3	3	3	2	3	1	2	3	1	2	2	2	3	3	3
DECP504A.5	3	2	3	3	3	3	2	3	1	2	3	1	2	2	2	3	3	3
DECP504A.6	3	2	3	3	3	3	2	3	1	2	3	1	2	2	2	3	3	3
DECP504A.7	3	2	3	3	3	3	2	3	1	2	3	1	2	2	2	3	3	3
DECP504A.8	3	2	3	3	3	3	2	3	1	2	3	1	2	2	2	3	3	3

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER V
CODE: DECP-505A
SUBJECT NAME: BIOLOGICAL & MEDICAL PHYSICS
NO. OF CREDITS: 6

L	T	P		
			SESSIONAL	: 25
			FINAL EXAM	: 75
5	1	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-A is compulsory and contains 10 questions each of 1.5 marks covering the entire syllabus. Part-B has 6 questions each of 15 marks and students are required to attempt any four questions from this part.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

DECP505A.1	*Learn the basics of living cells, biological systems and their scaling laws.*
DECP505A.2	*Understand the energy storage and growth mechanisms in the human body.*
DECP505A.3	*Examine the molecular motion in cells by studying the diffusion processes and transport along microtubules.*
DECP505A.4	*Analyze the brain structure and various evolution models in organisms.*
DECP505A.5	*Understand the physical concepts of the human body related to the optical system like eye, electrical signals and acoustic systems.*
DECP505A.6	*Explore the physics of various diagnostic systems and their effect on the human body*.

UNIT-I

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. (12 Lectures)

UNIT-II

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).

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. (18 Lectures)

UNIT-III

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.

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.

(15 Lectures)

UNIT-IV

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.

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.

(15 Lectures)

Reference Books:

1. Biological Physics: Energy, Information, Life; Philip Nelson (W H Freeman &Co, NY, 2004)
2. Physical Biology of the Cell (2nd Edition); Rob Phillips et al (Garland Science, Taylor & Francis Group, London & NY, 2013)
3. An Introduction to Systems Biology; Uri Alon (Chapman and Hall/CRC, Special Indian Edition, 2013) Evolution; M. Ridley (Blackwell Publishers, 2009, 3rd edition)
4. Medical Physics, J.R. Cameron and J.G.Skofronick, Wiley (1978)
5. Basic Radiological Physics Dr. K.Thayalan- Jayapee Brothers Medical Publishing Pvt. Ltd. New Delhi (2003)
6. Christensen‟s Physics of Diagnostic Radiology: Curry, Dowdey and Murry - Lippincot Williams and Wilkins (1990)
7. Physics of the human body, Irving P. Herman, Springer (2007).
8. Physics of Radiation Therapy: F M Khan - Williams and Wilkins, 3rdedition (2003)
9. The essential physics of Medical Imaging: Bushberg, Seibert, Leidholdt and Boone Lippincot Williams and Wilkins, Second Edition (2002)
10. Handbook of Physics in Diagnostic Imaging: R.S.Livingstone: B.I. Publication Pvt Ltd.
11. The Physics of Radiology-H E Johns and Cunningham.

SUGGESTED WEB SOURCES:

1. NPTEL :: Courses
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for DECP-505A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
DECP505A.1	3	-	2	2	2	3	-	1	1	-	-	-	-	-	-	3	2	1
DECP505A.2	3	-	2	2	2	3	-	1	1	-	1	-	-	-	-	3	2	1
DECP505A.3	3	1	3	3	3	3	1	2	1	2	2	-	2	-	1	3	3	2
DECP505A.4	3	1	3	3	3	3	1	2	1	2	2	-	2	-	2	3	3	2
DECP505A.5	3	-	3	3	3	3	1	2	1	2	2	-	2	-	1	3	3	2
DECP505A.6	3	1	3	3	3	3	2	3	1	2	2	-	2	-	2	3	3	2

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER V
CODE: DECP-506A
SUBJECT NAME: ASTRONOMY & ASTROPHYSICS
NO. OF CREDITS: 6

			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
5	1	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-A is compulsory and contains 10 questions each of 1.5 marks covering the entire syllabus. Part-B has 6 questions each of 15 marks and students are required to attempt any four questions from this part.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

DECP506A.1	*Learn the basics of the Astronomical scale and complete life cycle of a star.*
DECP506A.2	*Explore astronomical techniques involving detectors and optical telescopes.*
DECP506A.3	*Understand characteristics features of the Sun and stellar spectra.*
DECP506A.4	*Learn about Galaxies and basics of Milky way Galaxies.*
DECP506A.5	*Understand Black Body Approximation, H R Diagram and Luminosity Classification in stellar spectra.*
DECP506A.6	*Analyze large scale structure & the law for expanding universe.*

UNIT-I

Astronomical Scales: Astronomical Distance, Mass and Time, Scales, Brightness,Radiant Flux and Luminosity, Measurement of Astronomical Quantities Astronomical Distances, Stellar Radii, Masses of Stars, Stellar Temperature. Basic concepts of positional astronomy: Celestial Sphere, Measurement of Time, Apparent Solar Time, Equation of time, Basic Parameters of Stars: Determination of Distance by Parallax Method; Brightness, Determination of Temperature and Radius of a star; Determination of Masses from Binary orbits; Hertzsprung-Russell Diagram.

(15 Lectures)

UNIT-II

Astronomical techniques: Basic Optical Definitions for Astronomy (Magnification of Light Gathering Power, Resolving Power and Diffraction Limit, Atmospheric Windows), Optical Telescopes (Types of Reflecting Telescopes, Telescope Mountings, Space Telescopes, Detectors and Their Use with Telescopes (Types of Detectors, detection Limits with Telescopes). Physical principles: Gravitation in Astrophysics (Virial Theorem, Newton versus Einstein).

(15 Lectures)

UNIT-III

The sun (Solar Parameters, Solar Photosphere, Solar Atmosphere, Chromosphere.Corona, Solar Activity, Basics of Solar Magneto-hydrodynamics. Helioseismology). The solar family (Solar System: Facts and Figures, Origin of the Solar System: The Nebular Model, Tidal Forces and Planetary Rings, Extra-Solar Planets.

Stellar spectra and classification Structure (Atomic Spectra Revisited, Stellar Spectra, Spectral Types and Their Temperature Dependence, Black Body Approximation, H R Diagram, Luminosity Classification)

The milky way : Basic Structure and Properties of the Milky Way, Nature of Rotation of the Milky Way (Differential Rotation of the Galaxy and Oort Constant, Rotation Curve of the Galaxy and the Dark Matter, Nature of the Spiral Arms), Stars and Star Clusters of the Milky Way, Properties of and around the Galactic Nucleus. (15 Lectures)

UNIT-IV

Galaxies: Galaxy Morphology, Hubble's Classification of Galaxies, Elliptical Galaxies (The Intrinsic Shapes of Elliptical, de Vaucouleurs Law, Stars and Gas). Spiral and Lenticular Galaxies (Bulges, Disks, Galactic Halo) The Milky Way Galaxy, Gas and Dust in the Galaxy, Spiral Arms.

Large scale structure & expanding universe: Cosmic Distance Ladder (An Example from Terrestrial Physics, Distance Measurement using Cepheid Variables), Hubble's Law (DistanceVelocity Relation), Clusters of Galaxies (Virial theorem and Dark Matter).

(15 Lectures)

Reference Books:

1. Modern Astrophysics, B.W. Carroll & D.A. Ostlie, Addison-Wesley Publishing Co.
2. Introductory Astronomy and Astrophysics, M. Zeilik and S.A. Gregory, 4th Edition, Saunders College Publishing.
3. The physical universe: An introduction to astronomy, F.Shu, Mill Valley: University Science Books.
4. Fundamentals of Astronomy (Fourth Edition), H. Karttunen et al. Springer.
5. K.S. Krishnasamy, 'Astro Physics a modern perspective,' Reprint, New Age International (p) Ltd, New Delhi,2002.
6. Baidyanath Basu, 'An introduction to Astrophysics', Second printing, Prentice -Hall of India Private limited, New Delhi,2001.
7. Textbook of Astronomy and Astrophysics with elements of cosmology, V.B. Bhatia, Narosa Publication.

SUGGESTED WEB SOURCES:

1. NPTEL :: Courses
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for DECP-506A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
DECP506A.1	3	1	2	2	2	2	1	3	1	2	2	-	2	1	2	3	3	1
DECP506A.2	3	1	2	2	2	2	1	3	1	2	2	-	2	1	2	3	3	1
DECP506A.3	3	1	2	2	2	2	1	3	1	2	2	-	2	1	2	3	3	1
DECP506A.4	3	1	2	2	2	2	1	3	1	2	2	-	2	1	2	3	3	1
DECP506A.5	3	1	2	2	2	2	1	3	1	2	2	-	2	1	2	3	3	1
DECP506A.6	3	1	2	2	2	2	1	3	1	2	2	-	2	1	2	3	3	2

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

Syllabus of B.Sc. (H) Physics

Semester VI

Discipline Core Course (DCC)

B.Sc. (H) PHYSICS SEMESTER VI
CODE: BPH-601A
SUBJECT NAME: ELECTROMAGNETIC THEORY
NO. OF CREDITS: 4

L	T	P		
			SESSIONAL	: 25
			FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-A is compulsory and contains 10 questions each of 1.5 marks covering the entire syllabus. Part-B has 6 questions each of 15 marks and students are required to attempt any four questions from this part.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

BPH601A.1 *Understand the concepts of electrical circuits and network theorems.*

BPH601A.2 *Solve the problems in direct current circuits using the basics of network theorems.*

BPH601A.3 *Learn the concepts of electrostatics and magnetostatics.*

BPH601A.4 *Analyze the problems of electrostatics and magnetostatics in matter.*

BPH601A.5 *Expertise the behaviour of dielectrics and magnetic materials in the presence of external electric fields and magnetic fields respectively.*

BPH601A.6 *Understand the concept of electromagnetic induction.*

UNIT-I

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. (10 Lectures)

UNIT-II

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.

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) (18 Lectures)

UNIT-III

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. (10 Lectures)

UNIT-IV

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.

Optical Fibres: Numerical Aperture. Step and Graded Indices (Definitions Only). Single and Multiple Mode Fibres. (10 Lectures)

Reference Books:

1. Introduction to Electrodynamics, D.J. Griffiths, 3rd Ed., 1998, Benjamin Cummings.
2. Electromagnetic Field and Waves, P. Lorrain and D. Corson, 2nd Ed., 2003, CBS Publisher.
3. Elements of Electromagnetics, M.N.O. Sadiku, 2001, Oxford University Press.
4. Fundamentals of Electromagnetics, M.A.W. Miah, 1982, Tata McGraw Hill
5. Electromagnetic field Theory, R.S. Kshetrimayun, 2012, Cengage Learning
6. Engineering Electromagnetic, Willian H. Hayt, 8th Edition, 2012, McGraw Hill.
7. Electromagnetics, J.A. Edminster, Schaum Series, 2006, Tata McGraw Hill.
8. Electromagnetic field theory fundamentals, B.Guru and H.Hiziroglu, 2015, Cambridge University Press
9. Classical Electrodynamics, J.D. Jackson, 3rd Edn., 2010, Wiley
10. Principle of Optics, M. Born and E. Wolf, 6th Edn., 1980, Pergamon Press
11. Optics, A. Ghatak, 5th Edn., 2012, Tata McGraw Hill Education.

SUGGESTED WEB SOURCES:

1. NPTEL :: Courses
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for BPH-601A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
BPH601A.1	3	1	3	3	3	2	1	3	1	2	1	-	2	1	2	3	3	1
BPH601A.2	3	1	3	3	3	2	1	3	1	2	1	-	2	1	2	3	3	2
BPH601A.3	3	1	3	3	3	2	1	3	1	1	1	-	1	1	2	3	3	1
BPH601A.4	3	1	3	3	3	2	1	3	1	2	1	-	2	1	2	3	3	2
BPH601A.5	3	1	3	3	3	2	1	3	1	2	1	-	2	1	2	3	3	2
BPH601A.6	3	1	3	3	3	2	1	3	1	2	1	-	2	1	2	3	3	1

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER VI
CODE: BPH-602A
SUBJECT NAME: STATISTICAL MECHANICS
NO. OF CREDITS: 4

L	T	P		
			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-A is compulsory and contains 10 questions each of 1.5 marks covering the entire syllabus. Part-B has 6 questions each of 15 marks and students are required to attempt any four questions from this part.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

BPH602A.1 *Understand the concepts of microstate, macrostate, ensemble, phase space, thermodynamic probability and partition function.*

BPH602A.2 *Understand the combinatorial studies of particles with their distinguishably or indistinguishably nature and conditions which lead to the three different distribution laws e.g. Maxwell-Boltzmann distribution, Bose-Einstein distribution and Fermi-Dirac distribution laws of particles and their derivation.*

BPH602A.3 *Comprehend and articulate the connection as well as dichotomy between classical statistical mechanics and quantum statistical mechanics.*

BPH602A.4 *Apply the classical statistical mechanics to derive the law of equipartition of energy and specific heat, classical radiation laws of black body radiation. Wien's law, Rayleigh Jeans law, ultraviolet catastrophe and Saha ionization formula.*

BPH602A.5 *Understand the Gibbs paradox, equipartition of energy and concept of negative temperature in two level system.*

BPH602A.6 *Calculate the macroscopic properties of degenerate photon gas using BE distribution law and understand Bose-Einstein condensation law, the concept of Fermi energy and Fermi level.*

Unit-I

Classical Statistics: Macrostate and Microstate, Phase Space, Elementary Concept of Ensemble, Entropy and Thermodynamic Probability, Maxwell-Boltzmann Distribution Law, Partition Function, Thermodynamic properties of a system, 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. (14 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. (10 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.
(10 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)

Reference Books:

1. Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.
2. Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill
3. Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.
4. An Introduction to Statistical Mechanics & Thermodynamics, R.H.Swendsen, 2012, Oxford Univ. Press
5. Statistical Physics , F. Mandl, 2nd Edn., 2003, Wiley
6. Introductory Statistical Mechanics, R. Bowley and M. Sanchez, 2nd Edn., 2007, Oxford Univ. Press
7. A treatise on Heat, M. N. Saha and B.N. Srivastava.

SUGGESTED WEB SOURCES:

1. NPTEL :: Courses
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for BPH-602A

Course Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PO13**	**PO14**	**PO15**	**PSO1**	**PSO2**	**PSO3**
BPH602A.1	3	3	3	3	3	3	2	3	3	2	3	3	3	3	3	3	2	2
BPH602A.2	3	3	3	3	2	3	2	3	3	2	3	3	3	3	3	3	2	2
BPH602A.3	3	3	3	3	2	3	2	2	3	2	2	3	3	3	3	3	2	2
BPH602A.4	3	3	3	3	2	3	2	2	3	2	2	3	3	3	3	3	2	2
BPH602A.5	3	3	2	3	2	3	2	2	3	2	3	3	3	2	3	3	2	2
BPH602A.6	3	3	2	3	2	3	2	2	3	2	2	3	3	2	3	3	2	2

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER VI
CODE: BPH-603A
SUBJECT NAME: ELECTROMAGNETIC THEORY LAB
NO. OF CREDITS: 2

L	T	P		
			SESSIONAL	: 15
			FINAL EXAM	: 35
0	0	2	TOTAL	: 50

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

BPH603A.1 *Determine the wavelength and velocity of ultrasonic waves in a liquid and refractive index of liquid/glass by total internal reflection.*

BPH603A.2 *Verify Malus's law, Stefan's law of radiation and Brewster's law.*

BPH603A.3 *Analyze elliptically polarized Light by using a Babinet's compensator.*

BPH603A.4 *Predict the specific rotation of sugar solution using Polarimeter.*

BPH603A.5 *Understand the reflection, refraction and polarization of microwaves.*

BPH603A.6 *Determine Boltzmann constant using V-I characteristics of PN junction diode.*

BPH603A.7 *Find Numerical Aperture of an Optical Fibre.*

BPH603A.8 *Understand polarization of light by reflection and determine the polarizing angle for air-glass interface.*

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:

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
3. Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer

SUGGESTED WEB SOURCES:

1. Virtual Labs (vlab.co.in)

MODE OF TRANSACTION: Demonstration, E-tutoring, discussion; **LMS/ICT Tools:** Online Resources.

Mapping of CO and PO for BPH-603A

Course Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PO13**	**PO14**	**PO15**	**PSO1**	**PSO2**	**PSO3**
BPH603A.1	3	2	3	3	3	3	2	3	1	2	1	1	2	2	2	3	3	3
BPH603A.2	3	2	3	3	3	3	2	3	1	2	1	1	2	2	2	3	3	3
BPH603A.3	3	2	3	3	3	3	2	3	1	1	1	1	2	2	2	3	3	3
BPH603A.4	3	2	3	3	3	3	2	3	1	2	1	1	2	2	2	3	3	3
BPH603A.5	3	2	3	3	3	3	2	3	1	2	1	1	2	2	2	3	3	3
BPH603A.6	3	2	3	3	3	3	2	3	1	2	1	1	2	2	2	3	3	3
BPH603A.7	3	2	3	3	3	3	2	3	1	2	1	1	2	2	2	3	3	3
BPH603A.8	3	2	3	3	3	3	2	3	1	2	1	1	2	2	2	3	3	3

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER VI
CODE: BPH-604A
SUBJECT NAME: STATISTICAL MECHANICS LAB
NO. OF CREDITS: 2

L	T	P		
			SESSIONAL	: 15
L	T	P	FINAL EXAM	: 35
0	0	2	TOTAL	: 50

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

BPH604A.1 *Study and understand 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 using simulation.*

BPH604A.2 *Understand and plot Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac distribution function of N number of particles.*

BPH604A.3 *Understand Planck's law for Black Body radiation and compare it with Rayleigh-Jeans Law at large and small wavelength for a given temperature.*

BPH604A.4 *Study and comprehend Specific Heat of Solids (a) Dulong-Petit law, (b) Einstein distribution function, (c) Debye distribution function for high temperature and low temperature.*

BPH604A.5 *Verify Stefan's Law of radiation and determine Stefan's constant.*

BPH604A.6 *Design and perform some experiments to determine Boltzmann' Constant.*

BPH604A.7 *Determine the Planck's constant using light emitting diodes.*

BPH604A.8 *Plot the distribution of relativistic and non-relativistic bosons and fermions as a function of energy, both at high and low temperature particles.*

At least 6 experiments from the following:

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 $Z(\beta)$ 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 ($dN/d\varepsilon$ 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:

1. ElementaryNumericalAnalysis, K.E.Atkinson, 3rd Edn. 2007, WileyIndiaEdition
2. Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.
3. Introduction to Modern Statistical Mechanics, D.Chandler, Oxford University Press, 1987
4. Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.
5. Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer
6. Statistical and Thermal Physics with computer applications, Harvey Gould and Jan Tobochnik, Princeton University Press, 2010.

SUGGESTED WEB SOURCES:

1. [Virtual Labs (vlab.co.in)](vlab.co.in)

MODE OF TRANSACTION: Demonstration, E-tutoring, discussion; **LMS/ICT Tools:** Online Resources.

Mapping of CO and PO for BPH-604A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
BPH604A.1	3	3	3	3	3	3	2	3	3	2	3	3	3	3	3	3	2	2
BPH604A.2	3	3	3	3	2	3	2	3	3	2	3	3	3	3	3	3	2	2
BPH604A.3	3	3	3	3	2	3	2	2	3	2	2	3	3	3	3	3	2	2
BPH604A.4	3	3	3	3	2	3	2	2	3	2	2	3	3	3	3	3	2	2
BPH604A.5	3	3	2	3	2	3	2	2	3	2	3	3	3	2	3	3	2	2
BPH604A.6	3	3	2	3	2	3	2	2	3	2	2	3	3	2	3	3	2	2
BPH604A.7	3	3	2	3	2	3	2	2	3	2	2	3	3	2	3	3	2	2
BPH604A.8	3	3	2	3	2	3	2	2	3	2	2	3	3	2	3	3	2	2

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

Discipline Elective Course in Physics (DECP) Semester-VI

Select any two papers and corresponding lab (if any)

B.Sc. (H) PHYSICS SEMESTER VI
CODE: DECP-601A
SUBJECT NAME: NUCLEAR AND PARTICLE PHYSICS
NO. OF CREDITS: 6

L	T	P		
			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
5	1	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-A is compulsory and contains 10 questions each of 1.5 marks covering the entire syllabus. Part-B has 6 questions each of 15 marks and students are required to attempt any four questions from this part.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

DECP601A.1 *Interpret the general facts and fundamental properties of nucleus.*

DECP601A.2 *Illustrate the various nuclear models such as Liquid drop model, Nuclear shell model, Fermi gas model etc. and their roles in explaining the ground state properties of nuclei.*

DECP601A.3 *Describe the nuclear decays and nuclear reactions along with their occurrence probabilities.*

DECP601A.4 *Explain 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.*

DECP601A.5 *Describe the principles and basic constructions of particle accelerators such as the Van-de-Graaff generator, cyclotron, betatron and synchrotron.*

DECP601A.6 *Acquire a thorough understanding of the fundamental interactions, elementary particles, the classifications of particles: leptons, hadrons (baryons and mesons), conservation laws and quarks models for elementary particles.*

Unit-I

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 quadrupole moment.

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 (15 Lectures)

Unit-II

Radioactivity decay: (a) Alpha decay: basics of α-decay processes, theory of α-emission, Gamow's theory of α-decay 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

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).

(15 Lectures)

Unit-III

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.

Detector for Nuclear Radiations: Gas filled detectors: Basic principle, 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. (15 Lectures)

Unit-IV

Particle Accelerators: Accelerator facility available in India: Van-de Graaff generator (Tandem accelerator), Linear accelerator, Cyclotron, Synchrotrons (Principle, construction, working, advantages and disadvantages). .

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.

(15 Lectures)

Reference Books:

1. Nuclear Physics by I. Kapelon.
2. Nuclear Physics by W.E. Burcham.
3. Nuclear Physics by Enge.
4. Atomic Nucleus by Evans.
5. Nuclear Physics by S. N. Ghoshal, First edition, S. Chand Publication, 2010.
6. Concepts of Nuclear Physics by Bernard L Cohen, Tata McGraw Hill Publication, 1974.
7. Introductory Nuclear Physics by Kenneth S, Krane, Wiley-India Publication, 2008
8. Radiation detection and measurement, G.F. Knoll, John Wiley & Sons, 2010.
9. Introduction to elementary particles by David J Griffiths, Wiley, 2008.

SUGGESTED WEB SOURCES:

1. NPTEL :: Courses
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for DECP-601A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
DECP601A.1	3	3	2	3	2	1	2	3	3	1	2	-	3	-	3	3	3	2
DECP601A.2	3	3	3	3	3	2	3	3	3	2	2	-	3	-	3	3	3	2
DECP601A.3	3	3	2	2	2	2	2	3	3	2	2	-	2	-	3	3	3	3
DECP601A.4	3	3	3	3	3	1	3	3	3	1	3	-	3	-	3	3	3	3
DECP601A.5	3	3	3	3	3	1	3	3	3	2	3	-	3	-	3	3	3	3
DECP601A.6	3	3	2	2	2	2	3	3	3	2	3	-	2	-	3	3	2	2

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER VI
CODE: DECP-602A
SUBJECT NAME: NANO MATERIALS AND APPLICATIONS
NO. OF CREDITS: 4

			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-A is compulsory and contains 10 questions each of 1.5 marks covering the entire syllabus. Part-B has 6 questions each of 15 marks and students are required to attempt any four questions from this part.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

DECP602A.1	*Understand the basics of Nano Science and Nano Technology*.
DECP602A.2	*Apply the Quantum Mechanics for Nanomaterials.*
DECP602A.3	*Learn the various Growth Techniques of Nanomaterials.*
DECP602A.4	*Use the Characterization Tools of Nanomaterials for research applications.*
DECP602A.5	*Aware about the optical properties of nanomaterials.*
DECP602A.6	*Understand the application of nanomaterial.*

Unit-I

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.

(12 Lectures)

Unit-II

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.

CHARACTERIZATION: X-Ray Diffraction. Optical Microscopy. Scanning Electron Microscopy. Transmission Electron Microscopy. Atomic Force Microscopy. Scanning Tunneling Microscopy. (12 Lectures)

Unit-III

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.~~ (12 Lectures)

~~**ELECTRON TRANSPORT**: Carrier transport in nanostrcutures. Coulomb blockade effect, thermionic emission, tunneling and hopping conductivity. Defects and impurities: Deep level and surface defects.~~

Unit-IV

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).

(12 Lectures)

Reference books:

1. C.P.Poole, Jr. Frank J.Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.)
2. S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publishing Company)
3. K.K. Chattopadhyay and A. N. Banerjee, Introduction to Nanoscience and Technology (PHI Learning Private Limited).
4. Introduction to Nanoelectronics, V.V. Mitin, V.A. Kochelap and M.A. Stroscio, 2011, Cambridge University Press.
5. Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).

SUGGESTED WEB SOURCES:

1. NPTEL :: Courses
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for DECP-602A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
DECP602A.1	3	2	2	2	2	3	2	3	1	1	2	-	2	1	2	3	3	3
DECP602A.2	3	2	3	3	3	3	2	3	2	2	3	-	3	2	3	3	3	3
DECP602A.3	3	2	2	2	2	3	2	3	1	1	2	-	2	1	2	3	3	3
DECP602A.4	3	2	3	3	3	3	2	3	2	2	3	-	3	2	3	3	3	3
DECP602A.5	3	2	3	3	3	3	2	3	2	2	3	-	3	2	3	3	3	3
DECP602A.6	3	2	3	3	3	3	2	3	2	2	3	-	3	2	3	3	3	3

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER VI
CODE: DECP-603A
SUBJECT NAME: PHYSICS OF DEVICES AND COMMUNICATION
NO. OF CREDITS: 4

L	T	P		
			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-A is compulsory and contains 10 questions each of 1.5 marks covering the entire syllabus. Part-B has 6 questions each of 15 marks and students are required to attempt any four questions from this part.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

DECP603A.1	*Understand the fabrication and study of advanced electronic device.*
DECP603A.2	*Learn the basics of IC fabrication process and various scales of IC fabrication.*
DECP603A.3	*Learn various electronic filters and Phase Locked Loop circuits.*
DECP603A.4	*Understand standards of communication the various communication systems.*
DECP603A.5	*Explore frequency modulation and demodulation.*
DECP603A.6	*Examine metal oxide semiconductor based devices like MOSFETs.*

Unit-I

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.

(12 Lectures)

Unit-II

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. (12 Lectures)

Unit-III

RC Filters: Passive-Low pass and High pass filters, Active (1st order butterworth) –Low Pass, High Pass, Band Pass and band Reject Filters.

Ph**ase 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).

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. (12 Lectures)

Unit-IV

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. (12 lectures)

Reference Books:

1. Physics of Semiconductor Devices, S.M.Sze and K.K.Ng, 3rd Edition 2008, John Wiley & Sons
2. Op-Amps & Linear Integrated Circuits, R.A.Gayakwad,4 Ed. 2000, PHI Learning Pvt. Ltd
3. Electronic Devices and Circuits, A. Mottershead, 1998, PHI Learning Pvt. Ltd
4. Electronic Communication systems, G. Kennedy, 1999, Tata McGraw Hill.
5. Introduction to Measurements & Instrumentation, A.K.Ghosh, 3rd Edition, 2009, PHI Learning
6. Semiconductor Physics and Devices, D.A. Neamen, 2011, 4th Edition, McGraw Hill
7. PC based instrumentation; Concepts and Practice, N. Mathivanan, 2007, Prentice-Hall of India.

SUGGESTED WEB SOURCES:

1. NPTEL :: Courses
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for DECP-603A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
DECP603A.1	3	2	2	2	2	3	2	3	1	1	2	-	2	1	2	3	3	3
DECP603A.2	3	2	2	2	2	3	2	3	1	1	2	-	2	1	2	3	3	3
DECP603A.3	3	2	2	2	2	3	2	3	1	1	2	-	2	1	2	3	3	3
DECP603A.4	3	2	3	3	3	3	2	3	2	2	3	-	3	2	3	3	3	3
DECP603A.5	3	2	3	3	3	3	2	3	2	2	3	-	3	2	3	3	3	3
DECP603A.6	3	2	3	3	3	3	2	3	2	2	3	-	3	2	3	3	3	3

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER VI
CODE: DECP-604A
SUBJECT NAME: NANO MATERIALS AND APPLICATIONS LAB
NO. OF CREDITS: 2

			SESSIONAL	: 15
L	T	P	FINAL EXAM	: 35
0	0	4	TOTAL	: 50

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

DECP604A.1 *Synthesize metal or semiconductor nanoparticles by chemical route.*

DECP604A.2 *Analyze XRD pattern of nanomaterials and estimate particle size.*

DECP604A.3 *Prepare composite of carbon nanotubes CNTs with other materials.*

DECP604A.4 *Grow quantum dots by thermal evaporation.*

DECP604A.5 *Prepare disc of ceramic of a compound using ball milling, pressing and sintering.*

DECP604A.6 *Fabricate thin film of nanoparticles by spin coating (or chemical route).*

DECP604A.7 *Prepare thin film capacitor and measure capacitance as a function of temperature or frequency.*

DECP604A.8 *Fabricate PN diode by diffusing Al over the surface of N-type Si and analyze its V-I characteristic.*

At least 06 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:

1. C.P.Poole, Jr. Frank J.Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.).
2. S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publishing Company).
3. K.K. Chattopadhyay and A.N. Banerjee, Introduction to Nanoscience & Technology (PHI Learning Private Limited).
4. Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).

SUGGESTED WEB SOURCES:

1. Virtual Labs (vlab.co.in)

MODE OF TRANSACTION: Demonstration, E-tutoring, discussion; **LMS/ICT Tools:** Online Resources.

Mapping of CO and PO for DECP-604A

Course Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PO13**	**PO14**	**PO15**	**PSO1**	**PSO2**	**PSO3**
DECP604A.1	3	2	3	3	3	3	2	3	2	2	2	-	3	1	3	3	3	3
DECP604A.2	3	2	3	3	3	3	2	3	2	2	2	-	3	1	3	3	3	3
DECP604A.3	3	2	3	3	3	3	2	3	2	2	2	-	3	1	3	3	3	3
DECP604A.4	3	2	3	3	3	3	2	3	2	2	2	-	3	1	3	3	3	3
DECP604A.5	3	2	3	3	3	3	2	3	2	2	2	-	3	1	3	3	3	3
DECP604A.6	3	2	3	3	3	3	2	3	2	2	2	-	3	1	3	3	3	3
DECP604A.7	3	2	3	3	3	3	2	3	2	2	2	-	3	1	3	3	3	3
DECP604A.8	3	2	3	3	3	3	2	3	2	2	2	-	3	1	3	3	3	3

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER VI
CODE: DECP-605A
SUBJECT NAME: PHYSICS OF DEVICES AND COMMUNICATION LAB
NO. OF CREDITS: 2

				SESSIONAL	: 15
L	T	P		FINAL EXAM	: 35
0	0	4		TOTAL	: 50

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

DECP605A.1	*Design and analyze the Clippers and Clampers circuits, power supply using bridge rectifier, and active low and high pass filters.*
DECP605A.2	*Analyze the output characteristics of junction field effect transistor and metal oxide semiconductor field effect transistor.*
DECP605A.3	*Understand amplitude modulation using transistor.*
DECP605A.4	*Design an Astable multivibrator of given specifications.*
DECP605A.5	*Understand characteristics of a Uni-junction Transistor and design a simple Relaxation Oscillator*
DECP605A.6	*Design analog pulse modulation techniques and Pulse code modulation using ICs.*
DECP605A.7	*Analyze lock and capture range of Phase-locked loop.*
DECP605A.8	*Simulate electronic circuits and devices using SPICE/MULTISIM.*

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:

1. Basic Electronics: A text lab manual, P.B.Zbar, A.P.Malvino, M.A.Miller,1994, Mc-Graw Hill
2. Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
3. Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
4. OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4^{th} edn., 2000, Prentice Hall.
5. Introduction to PSPICE using ORCAD for circuits& Electronics, M.H.Rashid,2003, PHI Learning.
6. PC based instrumentation; Concepts & Practice, N.Mathivanan, 2007, Prentice-Hall of India.

SUGGESTED WEB SOURCES:

1. Virtual Labs (vlab.co.in)

MODE OF TRANSACTION: Demonstration, E-tutoring, discussion; **LMS/ICT Tools:** Online Resources.

Mapping of CO and PO for DECP-605A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
DECP605A.1	3	2	3	3	3	3	2	3	2	2	2	-	3	1	3	3	3	3
DECP605A.2	3	2	3	3	3	3	2	3	2	2	2	-	3	1	3	3	3	3
DECP605A.3	3	2	3	3	3	3	2	3	2	2	2	-	3	1	3	3	3	3
DECP605A.4	3	2	3	3	3	3	2	3	2	2	3	-	3	1	3	3	3	3
DECP605A.5	3	2	3	3	3	3	2	3	2	2	3	-	3	1	3	3	3	3
DECP605A.6	3	2	3	3	3	3	2	3	2	2	3	-	3	1	3	3	3	3
DECP605A.7	3	2	3	3	3	3	2	3	2	2	3	-	3	1	3	3	3	3
DECP605A.8	3	2	3	3	3	3	2	3	2	2	3	-	3	1	3	3	3	3

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

B.Sc. (H) PHYSICS SEMESTER VI
CODE: DECP-606A
SUBJECT NAME: CLASSICAL DYNAMICS
NO. OF CREDITS: 6

			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
5	1	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-A is compulsory and contains 10 questions each of 1.5 marks covering the entire syllabus. Part-B has 6 questions each of 15 marks and students are required to attempt any four questions from this part.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

DECP606A.1	*Acquire insightful knowledge of the Newtonian and Lagrangian formulations of classical mechanics and their applications in appropriate physical problems.*
DECP606A.2	*Describe the Hamiltonian formulation and apply the same over various physical systems.*
DECP606A.3	*Evaluate Poisson and Lagrange Brackets and establish relationships between their properties.*
DECP606A.4	*Develop a deep understanding to tackle the problems of small oscillations.*
DECP606A.5	*Demonstrate the concept of motion of a particle under central force and apply advanced methods to deal with central force problems.*
DECP606A.6	*Use Hamilton-Jacobi theory for finding the solutions of various Classical systems.*

Unit-I
Lagrangian 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 &~~ (15 lectures)

Unit-II

Hamiltonian formulations: 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. (15 Lectures)

Unit-III

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~~. ~~–~~

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. (18 Lectures)

Unit-IV

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. (12 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.~~

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.

SUGGESTED WEB SOURCES:

1. NPTEL :: Courses
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
3. https://swayam.gov.in/

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for DECP-606A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
DECP606A.1	3	3	3	3	3	1	3	3	3	3	2	-	1	-	3	3	3	2
DECP606A.2	3	3	3	3	3	2	3	3	3	3	3	-	2	-	3	3	3	2
DECP606A.3	3	3	3	3	3	1	3	3	2	3	3	-	2	-	3	3	3	1
DECP606A.4	3	3	3	3	3	2	3	3	2	2	2	-	2	-	3	3	3	2
DECP606A.5	3	3	3	3	3	1	2	3	3	3	2	-	2	-	3	3	3	1
DECP606A.6	3	3	3	3	3	1	2	3	2	2	2	-	2	-	3	3	3	1

**Mapping Scale: 1 to 3 (3: Strong correlation; 2: medium correlation; 1: weak correlation)

Mapping of the subjects with the following:

S. No.	Course Name	Course Code	Employability	Entrepreneurship	Skill Development
1.	Mathematical Physics-I	BPH-101A	√		
2.	Mechanics	BPH-102A	√		
3.	Mathematical Physics-I Lab	BPH-103A	√		
4.	Mechanics Lab	BPH-104A	√		
5.	Electricity & Magnetism	BPH-201A	√		
6.	Waves & Optics	BPH-202A	√		
7.	Electricity & Magnetism Lab	BPH-203A	√		
8.	Waves & Optics Lab	BPH-204A	√		
9.	Mathematical Physics-II	BPH-301A	√		
10.	Thermal Physics	BPH-302A	√		
11.	Analog Systems & Applications	BPH-303A	√		
12.	Mathematical Physics-II Lab	BPH-304A	√		
13.	Thermal Physics Lab	BPH-305A	√		
14.	Analog Systems & Applications Lab	BPH-306A	√		
15.	Mathematical Physics-III	BPH-401A	√		
16.	Elements of Modern Physics	BPH-402A	√		
17.	Digital Systems & Applications	BPH-403A	√		
18.	Mathematical Physics-III Lab	BPH-404A	√		
19.	Elements of Modern Physics Lab	BPH-405A	√		
20.	Digital Systems & Applications Lab	BPH-406A	√		
21.	Computational Physics Skills	SECP-01A	√	√	√
22.	Electrical Circuits & Network Skills	SECP-02A	√	√	√
23.	Basic Instrumentation Skills	SECP-03A	√	√	√
24.	Computational Physics Skills Lab	SECP-04A	√	√	√
25.	Electrical Circuits & Network Skills Lab	SECP-05A	√	√	√
26.	Basic Instrumentation Skills Lab	SECP-06A	√	√	√
27.	Renewable Energy and Energy Harvesting	SECP-07A	√	√	√
28.	Renewable Energy and Energy Harvesting Lab	SECP-08A	√	√	√

29.	Quantum Mechanics & Applications	BPH-501A	√		
30.	Solid State Physics	BPH-502A	√		
31.	Quantum Mechanics & Applications Lab	BPH-503A	√		
32.	Solid State Physics Lab	BPH-504A	√		
33.	Atomic & Molecular Physics	DECP-501A	√		
34.	Experimental Techniques	DECP-502A	√	√	√
35.	Linear Algebra & Tensor Analysis	DECP-503A	√		
36.	Experimental Techniques Lab	DECP-504A	√	√	√
37.	Biological & Medical Physics	DECP-505A		√	√
38.	Astronomy & Astrophysics	DECP-506A	√		√
39.	Electromagnetic Theory	BPH-601A	√		
40.	Statistical Mechanics	BPH-602A	√		
41.	Electromagnetic Theory Lab	BPH-603A	√		
42.	Statistical Mechanics Lab	BPH-604A	√		
43.	Nuclear & Particle Physics	DECP-601A	√		
44.	Nano Materials & Applications	DECP-602A	√	√	√
45.	Physics of Devices & Communication	DECP-603A	√	√	√
46.	Nano Materials & Applications Lab	DECP-604A	√	√	√
47.	Physics of Devices & Communication Lab	DECP-605A	√	√	√
48.	Classical Dynamics	DECP-606A	√		

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Accredited 'A' Grade by NAAC

Department of Physics

Program: M.Sc. Physics

Revised Scheme course index of the year 2020-21 (11th BOS dated 27/7/2021)

Mapping of the courses with the Employability/ Entrepreneurship/ Skill development

S. No.	Course Name	Course code	Employability	Entrepreneurship	Skill Development
1	Mathematical Physics	MPH101	√		
2	Classical Mechanics	MPH102	√		
3	Quantum Mechanics-I	MPH103	√		
4	Electronic Devices	MPH104	√	√	√
5	Physics Laboratory-I	MPH105	√	√	√
6	Seminar-I	MPH106	√	√	√
7	Quantum Mechanics - II	MPH201	√		
8	Nuclear and Particle Physics	MPH202	√		
9	Solid State Physics	MPH203	√		
10	Electrodynamics	MPH204	√		
11	Physics Laboratory-II	MPH205	√	√	√
12	Atomic and Molecular Physics	MPH301	√		
13	Statistical Mechanics	MPH302	√		
14	Laser Technology	MPH401	√	√	√

15	Materials Science	MPH402	√	√	√
16	Dissertation	MPH405	√	√	√
17	Nuclear Reactions	MPN303	√		
18	Nuclear Detectors	MPN304	√	√	√
19	Nuclear Physics Spec. Lab	MPN305	√	√	√
20	Nuclear Models and Astrophysics	MPN403	√		
21	Nuclear Techniques and Neutron Physics	MPN404	√		
22	Materials Characterization Techniques	MPM303	√	√	√
23	Fundamentals and synthesis of nanomaterials	MPM304	√	√	√
24	Material Science Spec. Lab	MPM305	√	√	√
25	Advanced Materials Science	MPM403	√	√	√
26	Vacuum Science and Thin Films Technology	MPM404	√	√	√
27	Analog Electronics	MPE303	√	√	√
28	Microprocessor	MPE304	√	√	√
29	Electronics Spec. Lab	MPE305	√	√	√
30	Digital Electronics	MPE403	√	√	√
31	Optical fiber Communication	MPE404	√	√	√
32	RENEWABLE ENERGY RESOURCES	APH101	√	√	√
33	INTRODUCTION TO ASTROPHYSICS AND COSMOLOGY	OPH101	√		
34	ENERGY HARVESTING AND STORAGE DEVICES	OPH102	√	√	√

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Department of Physics

Program: B.Sc. (Hons.) Physics **Course Code: 32**

Annexure 2B

Revised Scheme course index of the year 2020-21 (5th BOS dated 27/7/2021)

Mapping of the courses with the Employability/ Entrepreneurship/ Skill development

S. No.	Course Name	Course Code	Employability	Entrepreneurship	Skill Development
1.	Mathematical Physics-I	BPH-101A	√		
2.	Mechanics	BPH-102A	√		
3.	Mathematical Physics-I Lab	BPH-103A	√		
4.	Mechanics Lab	BPH-104A	√		
5.	Electricity & Magnetism	BPH-201A	√		
6.	Waves & Optics	BPH-202A	√		
7.	Electricity & Magnetism Lab	BPH-203A	√		
8.	Waves & Optics Lab	BPH-204A	√		
9.	Mathematical Physics-II	BPH-301A	√		
10.	Thermal Physics	BPH-302A	√		
11.	Analog Systems & Applications	BPH-303A	√		
12.	Mathematical Physics-II Lab	BPH-304A	√		
13.	Thermal Physics Lab	BPH-305A	√		
14.	Analog Systems & Applications Lab	BPH-306A	√		
15.	Mathematical Physics-III	BPH-401A	√		
16.	Elements of Modern Physics	BPH-402A	√		
17.	Digital Systems & Applications	BPH-403A	√		
18.	Mathematical Physics-III Lab	BPH-404A	√		

19.	Elements of Modern Physics Lab	BPH-405A	√		
20.	Digital Systems & Applications Lab	BPH-406A	√		
21.	Computational Physics Skills	SECP-01A	√	√	√
22.	Electrical Circuits & Network Skills	SECP-02A	√	√	√
23.	Basic Instrumentation Skills	SECP-03A	√	√	√
24.	Computational Physics Skills Lab	SECP-04A	√	√	√
25.	Electrical Circuits & Network Skills Lab	SECP-05A	√	√	√
26.	Basic Instrumentation Skills Lab	SECP-06A	√	√	√
27.	Renewable Energy and Energy Harvesting	SECP-07A	√	√	√
28.	Renewable Energy and Energy Harvesting Lab	SECP-08A	√	√	√
29.	Quantum Mechanics & Applications	BPH-501A	√		
30.	Solid State Physics	BPH-502A	√		
31.	Quantum Mechanics & Applications Lab	BPH-503A	√		
32.	Solid State Physics Lab	BPH-504A	√		
33.	Atomic & Molecular Physics	DECP-501A	√		
34.	Experimental Techniques	DECP-502A	√	√	√
35.	Linear Algebra & Tensor Analysis	DECP-503A	√		
36.	Experimental Techniques Lab	DECP-504A	√	√	√
37.	Biological & Medical Physics	DECP-505A		√	√
38.	Astronomy & Astrophysics	DECP-506A	√		√
39.	Electromagnetic Theory	BPH-601A	√		
40.	Statistical Mechanics	BPH-602A	√		
41.	Electromagnetic Theory Lab	BPH-603A	√		
42.	Statistical Mechanics Lab	BPH-604A	√		
43.	Nuclear & Particle Physics	DECP-601A	√		
44.	Nano Materials & Applications	DECP-602A	√	√	√
45.	Physics of Devices & Communication	DECP-603A	√	√	√
46.	Nano Materials & Applications Lab	DECP-604A	√	√	√

47.	Physics of Devices & Communication Lab	DECP-605A	√	√	√
48.	Classical Dynamics	DECP-606A	√		

Ashang