J.C. Bose University of Science & Technology, YMCA, Faridabad, Haryana
(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

Department of Physics

Date: 2/8/2023

To:

1	Prof. Anuradha Sharma Chairperson, Department of Physics, JCBUST, YMCA, Faridabad	Chairperson of the department and BOS
2	Prof. R.P. Chauhan Professor, NIT Kurukshetra	Outside Expert
3	Prof. Sanjeev Agarwal Professor, Department of Physics, KU	Outside Expert
4	Prof. Sandeep Grover Dean (Institutions)	Member
5	Dr. Anuj Kumar Arya Associate Professor, Department of Physics, JCBUST, YMCA, Faridabad	Member
6	Dr. Yogita Assistant Professor, Department of Physics, JCBUST, YMCA, Faridabad	Member

Subject: Minutes of the 1st Board of Studies (UG) meeting of the Department of Physics held on 3rd August, 2023 at 11.00 AM in the office of the Chairperson.

Sir/Madam,
Please find enclosed herewith the minutes of the 1st Board of Studies (UG) meeting of the Department of Physics held on 3rd August, 2023 at 11.00 AM in the office of the Chairperson for your kind perusal and information.

A Sharma 2/8/2023
Chairperson

Prof. Anuradha Sharma

Cc:
All Concerned

Department of Physics

Subject: Minutes of the 1st Board of Studies (UG) meeting of the Department of Physics held on 3rd August, 2023 at 11.00 AM in the office of the Chairperson.

Present:

1	Prof. Anuradha Sharma Chairperson, Department of Physics, JCBUST, YMCA, Faridabad	Chairperson of the department and BOS
2	Prof. R.P. Chauhan Professor, NIT Kurukshetra	Outside Expert
3	Prof. Sanjeev Agarwal Professor, Department of Physics, KU	Outside Expert
4	Prof. Sandeep Grover Dean (Institutions)	Member
5	Dr. Anuj Kumar Arya Associate Professor, Department of Physics, JCBUST, YMCA, Faridabad	Member
6	Dr. Yogita Assistant Professor, Department of Physics, JCBUST, YMCA, Faridabad	Member

At the onset, the Chairperson, Prof. Anuradha Sharma extended a hearty welcome to all the members of the BOS (UG) of the Department of Physics.

Thereafter, the agenda items were taken up and after detailed discussions, the following decisions were taken:

Item No.1.1	To welcome the members of newly constituted BOS (UG).
	The Chairperson welcomed the members of the newly formed Board of Studies (UG). It was informed that this was the first time that the department had constituted separate Board of Studies for UG and PG.
Item No. 1.2	To approve the minutes of the curriculum workshop held on 13th July, 2023 for UG (NEP) and Minor Degree programs to be started in the department w.e.f. session 2023-24.
	The minutes of the curriculum workshop held on 13th July, 2023 for UG (NEP) and Minor Degree programs to be started in the department w.e.f. session 2023-24 were presented. The 40% changes were done and approved in the scheme and syllabus of B.Sc. Physics to make it in accordance with

	NEP. The BOS approved the syllabi of the minor degree program in (i) Nanoscience and Nanotechnology (ii) Radiation Physics (iii) Renewable energy and (iv) B.Sc. Physics 1st year syllabus after minor modifications. (Annexure I).
Item No. 1.4	Any other item with the permission of the chair.
	No other item was discussed.

The meeting ended with a vote of thanks by the Chairperson.

A Sharma 3/8/2023.

Prof. Anuradha Sharma
Chairperson

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Department of Physics

Date: 2/8/2023

Agenda of the 1st Board of Studies (UG) meeting of the Department of Physics to be held on 3rd August, 2023 at 11.00 AM in the office of the Chairperson.

Item No. 1.1: To welcome the members of the newly constituted BOS (UG)

Item No. 1.2: To approve the minutes of the curriculum workshop held on 13th July, 2023 for UG (NEP) and Minor Degree programs to be started in the department w.e.f. session 2023-24

Item No. 1.3: Any other item with the permission of the chair

Prof. Anuradha Sharma 2/8/2023

Chairperson

J.C. Bose University of Science & Technology, YMCA, Faridabad, Haryana
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Department of Physics

Date: 15/7/2023

Subject: Minutes of the curriculum workshop held on 13th July, 2023 for UG(NEP) and Minor Degree Programs to be started in the department w.e.f. session 2023-24

A curriculum development workshop was **held on 13th July, 2023 for UG(NEP) and Minor Degree Programs to be started in the department w.e.f. session 2023-24.**

The following members attended the workshop:

Prof. Anuradha Sharma, Chairperson of the department

External Experts (joined in Online mode)

1. Prof. Amitava Patra, Director, INST Mohali
2. Prof. B.S. Rajput, Ex Vice Chancellor, Kumaun University

Internal Experts

1. Prof. Sonia Bansal (For Minor degree in Nanoscience and Nanotechnology)
2. Dr. Parveen Kumar (For B.Sc. Physics program-NEP)
3. Dr. Arun Kumar (For Minor degree in Radiation Physics)
4. Dr. Aman Joshi (For Minor degree in Renewable energy)
5. Dr. Yogita
6. Ms. Aarti Rajpal

At the start, Prof. Anuradha Sharma welcomed the all the committee members. The proceedings of the workshop are as follows:

1. Prof. Sonia Bansal presented the syllabus for the **Minor Degree Program in Nanoscience and Nanotechnology**. The experts suggested some modifications which were incorporated in the final syllabus.
2. Dr. Arun Kumar presented the syllabus for the **Minor Degree Program in Radiation Physics.** The experts suggested some modifications which were incorporated in the final syllabus.
3. Dr. Aman Joshi presented the syllabus for the **Minor Degree Program in Renewable Energy**. The experts suggested some modifications which were incorporated in the final syllabus.
4. Dr. Parveen Kumar syllabus presented the **scheme and syllabus (1st year) of B.Sc. Physics Hons. as per NEP-2020 and the subsequent Haryana Government guidelines**. Prof. Rajput suggested the addition of some topics in the Mathematical Physics papers. The final syllabus was modified accordingly.

The workshop ended with a vote of thanks by the Chairperson.

Dr. Aman Joshi

Dr. Arun Kumar

Dr. Parveen Kumar

Prof. Sonia Bansal

Prof. Anuradha Sharma

B.Sc. (H) Physics

Scheme and Syllabus

National Education Policy (NEP)-2020

Outcome Based Education System (OBES)/

Under Graduate Curriculum Framework (UGCF)

ACADEMIC SESSION

(w.e.f. 2023-2024)

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 program 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 program 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.) program 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.

Awarding UG Certificate, UG Diploma and UG Degrees

UG Certificate: Students who opt to exit after completion of the first year and have secured 44 credits will be awarded a UG certificate if, in addition, they complete one vocational course/summer internship of 4 credits during the summer vacation of the first year. These students are allowed to re-enter the degree programme within three years and complete the degree programme within the stipulated maximum period of seven years.

UG Diploma: Students who opt to exit after completion of the 2nd year and have secured 90 credits will be awarded the UG diploma if, in addition, they complete one vocational course/summer internship of 4 credits during the summer vacation of the second year. These students are allowed to re-enter within a period of three years and complete the degree programme within the maximum period of seven years.

3-year UG Degree: Students who wish to undergo a 3-year UG programme will be awarded UG Degree in the Major discipline after successful completion of three years, securing 136 credits and satisfying the minimum credit requirement as given in Table 1.

4-year UG Degree (Honours): A four—year UG Honours degree in the major discipline will be awarded to those who complete a 4-year degree programme with 184 credits and have satisfied the credit requirements as given in Table 1.

4-year UG Degree (Honours with Research): Students who secure 75% marks and above in the first six semesters and wish to undertake research at the undergraduate level can choose a research stream in the fourth year. They should do a research project or dissertation under the guidance of a faculty member of the University/College. The research project/dissertation will be in the major discipline. The students, who secure 184 credits including 12 credits from a research project/dissertation, are awarded UG Degree (Honours with Research).

Table-1: Semester Wise Credits Distribution

Semester	Discipline Specific Major	Minor/DSE	Multidisciplinary	Ability Enhancement Courses	Skill Enhancement Courses/ Internship	Value Added Courses	Research Project/ Dissertation	Total Credits
I	DSC-A1 @4 DSC-A2 @4	MIC1 @4	MDC1 @3	AEC1 @2	SEC1 @3	VAC1 @2	-	22
II	DSC-A3 @4 DSC-A4 @4	MIC2 @4	MDC2 @3	AEC2 @2	SEC2 @3	VAC2 @2	-	22
A Student exiting the programme after first year securing 48 credits including 4 credits of summer internship (in Industry/University) will be awarded UG Certificate in BSc Physics. ***Exit Criteria 44+4=48 credits***								
III	DSC-A5 @4 DSC-A6 @4	MIC3 @4	MDC3 @3	AEC3 @2	SEC3 @3	VAC3 @2	----------	22
IV	DSC-A7 @4 DSC-A8 @4 DSC-A9 @4 DSC-A10 @4	MIC4 (VOC)@4	----------	AEC4 @2	----------	VAC4 @2	---------	24
A Student exiting the programme after second year securing 94 credits including 4 credits of summer internship (in Industry/University) will be awarded UG								

Diploma in BSc Physics ***Exit Criteria 90+4=94 Credits***								
V	DSC-A11 @4 DSC-A12 @4 DSC-A13 @4 DSC-A14 @4	MIC5 (VOC)@4	----------	----------	Internship @4	----------	---------	24
VI	DSC-A15 @4 DSC-A16 @4 DSC-A17 @4 DSC-A18 @4	MIC6 (VOC) @4	----------	----------	SEC4 @2	---------	---------	22
A Student exiting the program after 3rd-year securing 136 credits will be awarded 3-year UG degree in BSc Physics. ***Exit Criteria 132+4= 136 Credits*** ***Students securing 75% or above marks upto 6th semester shall be eligible to opt for B.Sc. (Hons. with Research) in Physics.***								
VII	DSC-AH1 @4 DSC-AH2 @4	MIC7 @4	----------	----------	---------	-------	--------	24

	DSC-AH3 @4 DSC-AH4 @4 DSC-AH5 @4							
VIII* **(4-year UG Hons.)**	DSC-AH6 @4 DSC-AH7 @4 DSC-AH8 @4 DSC-AH9 @4 DSC-AH10 @4	MIC8 @4	----------	---------	----------	----------	---------	24
VIII (4-year UG Hons. With research)**	DSC-AH6 @4 DSC-AH7 @4	MIC8 @4					Research Project/ Dissertation @12	24
Total	**112*/100****	**32**	**09**	**08**	**15**	**08**	**00*/12****	**184**
Students securing 184 credits including research project/ dissertation of 12 credits will be awarded B.Sc. (Hons with Research) in Physics, while those who do not undertake research project / dissertation will be awarded B.Sc. (H) Physics degree.								

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.

SCHEME B.Sc. (H) PHYSICS
Semester- I

S. No.	Category	Course Code	Course Title	Hours per week			Credits	Marks for Sessional	Marks for End Term Examination	Total
				L	T	P				
1	Major DSC-A1 @4	BPH23-101T	Mathematical Physics-I	3	0	0	3	25	75	100
		BPH23-101P	Mathematical Physics-I Lab	0	0	2	1	15	35	50
2	Major DSC-A2 @4	BPH23-102T	Mechanics	3	0	0	3	25	75	100
		BPH23-102P	Mechanics Lab	0	0	2	1	15	35	50
3	Minor MIC1 @4	BPH23-103T	Waves and Oscillations	3	0	0	3	25	75	100
		BPH23-103P	Waves and Oscillations Lab	0	0	2	1	15	35	50
Multi-Disciplinary Course (MDC1) - Select one paper & respective Lab (if any) of the following 3-disciplines										
4	Multidisciplinary MDC1 @3	OMTHP23-101	Basic Calculus	2	1	0	3	25	75	100
		OEC-CE-1011	Fundamentals of Programming	2	0	0	2	25	75	100
		OEC-CE-1012	Fundamentals of Programming Lab	0	0	2	1	15	35	50
		OCHP23-101	Inorganic Chemistry-I	2	0	0	2	25	75	100
		OCHP23-102	Inorganic Chemistry-I Lab	0	0	2	1	15	35	50
5	Ability Enhancement courses AEC1 @2	AEC-101-N1	Writing Skills and the Art of Rhetoric (WSAAR)	2	0	0	2	25	75	100
Skill Enhancement Course (SEC1) - Select one paper & respective Lab (if any) of the following courses										

6	Skill Enhancement courses SEC1 @3	SECP23-101T	Computational Skills with C++	2	0	0	2	25	75	100
		SECP23-101P	Computational Skills with C++ Lab	0	0	2	1	15	35	50
		SECP23-102T	Basic Instrumentation Skills	2	0	0	2	25	75	100
		SECP23-102P	Basic Instrumentation Skills Lab	0	0	2	1	15	35	50
7	Value Added Courses VAC1 @2	VAC-101-N1	Environmental Studies-I (EVS-I)	2	0	0	2	25	75	100
Total				**-**	**-**	**-**	**22**			

NOTE: 1. Skill Enhancement Course (SEC), Value added course (VAC), Multidisciplinary course (MDC) papers may be added or deleted at later stage as per UGC guidelines and as per the availability.

Semester- II

S. No.	**Category**	**Course Code**	**Course Title**	**Hours per week**			**Credits**	**Marks for Sessional**	**Marks for End Term Examination**	**Total**
				L	**T**	**P**				
1	Major DSC-A3 @4	BPH23-201T	Mathematical Physics-II	3	0	0	3	25	75	100
		BPH23-201P	Mathematical Physics-II Lab	0	0	2	1	15	35	50
2	Major DSC-A4 @4	BPH23-202T	Electricity and Magnetism	3	0	0	3	25	75	100
		BPH23-202P	Electricity and Magnetism Lab	0	0	2	1	15	35	50
3	Minor MIC2 @4	BPH23-203T	Electrical Circuit Analysis	3	0	0	3	25	75	100
		BPH23-203P	Electrical Circuit Analysis Lab	0	0	2	1	15	35	50

Multi-Disciplinary Course (MDC2) - Select one paper & respective Lab (if any) of the following 3-disciplines										
4	Multidisciplinary MDC2 @3	OMTHP23-201	Linear Algebra	2	1	0	3	25	75	100
		OEC-CE-1013	Fundamentals of Database System	2	0	0	2	25	75	100
		OEC-CE-1014	Fundamentals of Database System Lab	0	0	2	1	15	35	50
		OCHP23-201	Inorganic Chemistry-II	2	0	0	2	25	75	100
		OCHP23-202	Inorganic Chemistry-II Lab	0	0	2	1	15	35	50
5	Ability Enhancement courses AEC2 @2	AEC-102-N1	Communication, Mediation and Resolution (CMR)	2	0	0	2	25	75	100
Skill Enhancement Course (SEC2) - Select any one paper & respective Lab (if any) of the following courses										
6	Skill Enhancement courses SEC2 @3	SECP23-201T	Computational Skills with Python	2	0	0	2	25	75	100
		SECP23-201P	Computational Skills with Python Lab	0	0	2	1	15	35	50
		SECP23-202T	Renewable Energy and Energy Harvesting	2	0	0	2	25	75	100
		SECP23-202P	Renewable Energy and Energy Harvesting Lab	0	0	2	1	15	35	50
7	Value Added Courses VAC2 @2	VAC-103-N1	Yoga and Meditation	2	0	0	2	25	75	100
Total				**-**	**-**	**-**	**22**			

NOTE: 1. Skill Enhancement Course (SEC), Value added course (VAC), Multidisciplinary course (MDC) papers may be added or deleted at later stage as per UGC guidelines and as per the availability.

Syllabus of B.Sc. (H) Physics

Semester I

Discipline Core Course (DCC)

B.Sc. (H) PHYSICS SEMESTER I
CODE: BPH23-101T
SUBJECT NAME: MATHEMATICAL PHYSICS-I
NO. OF CREDITS: 3

			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
3	0	0	TOTAL	: 100

Total : 36 Lecture

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 completing this course, student will be able to,

CO-1: Understand the vector quantities as entities with Cartesian components which satisfy appropriate rules of transformation under rotation of the axes.

CO-2: Use index notation to write the product of vectors in compact form easily applicable in computational work.

CO-3: Solve first and second order differential equations and apply these to physics problems.

CO-4: Understand the functions of more than one variable and concept of partial derivatives.

CO-5: Understand the concept of scalar field, vector field, gradient of scalar field and divergence and curl of vector fields.

CO-6: Perform line, surface and volume integration and apply Green's, Stokes' and Gauss's theorems to compute these integrals and apply these to physics problems.

Unit 1

Ordinary Differential Equations: First order differential equations of degree one and those reducible to this form, Exact and Inexact equations, Integrating Factor. **(3L)**

Higher order linear homogeneous differential equations with constant coefficients, Wronskian and linearly independent functions. Non-homogeneous second order linear differential equations with constant coefficients, complimentary function, particular integral and general solution. Determination of particular integral using method of undetermined coefficients and method of variation of parameters. **(9 L)**

Unit 2

Vector Algebra: Transformation of Cartesian components of vectors under rotation of the axes, Introduction to index notation and summation convention. Product of vectors - scalar and vector product of two, three and four vectors in index notation using and (as symbols only – no rigorous proof of properties). Invariance of scalar product under rotation transformation. **(8L)**

Unit-3

Vector Differential Calculus: Scalar and vector fields, concept of directional derivative, the vector differential del operator , gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field and their physical interpretation. Laplacian operator. Vector identities. **(7 L)**

Unit-4

Vector Integral Calculus: Integrals of vector-valued functions of single scalar variable. Multiple integrals, Jacobian,Notion of infinitesimal line, surface and volume elements. Line, surface and volume integrals of vector fields. Flux of a vector field. Gauss divergence theorem, Green's and Stokes' Theorems (no proofs) and their applications. **(9L)**

Reference Books:

1. Mathematical Methods for Physicists, G.B.Arfken, H.J.Weber, F.E.Harris, 1513, 7th Edn., Elsevier.
2. Mathematical Physics, H. K. Das, S. Chand Publications.
3. Mathematical Physics, B.S. Rajput, Pragati Prakashan, Meerut.
4. Mathematical Physics, Goswami, 1st edition, Cengage Learning
5. Engineering Mathematics, S.Pal and S.C. Bhunia, 1515, Oxford University Press
6. 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 BPH23-101T

Course Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PO13**	**PO14**	**PO15**	**PSO1**	**PSO2**	**PSO3**
CO-1	3	-	2	2	2	3	-	1	1	-	-	-	-	-	-	3	2	1
CO-2	3	-	3	3	3	3	-	2	1	-	2	-	-	-	-	3	3	2
CO-3	3	1	3	3	3	3	1	3	1	2	2	-	2	-	1	3	3	2
CO-4	3	-	2	2	2	3	-	1	1	-	1	-	-	-	-	3	2	1
CO-5	3	-	2	2	2	3	-	2	1	-	1	-	-	-	-	3	3	1
CO-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: BPH23-101P
SUBJECT NAME: MATHEMATICAL PHYSICS –I LAB
NO. OF CREDITS: 1

L	T	P
0	0	2

SESSIONAL : 15
FINAL EXAM : 35
TOTAL : 50

Topics	**Descriptions with Applications**
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 $0 \leq t \leq 15$.

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.

B.Sc. (H) PHYSICS SEMESTER I
CODE: BPH23-102T
SUBJECT NAME: MECHANICS
NO. OF CREDITS: 3

			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
3	0	0	TOTAL	: 100

Total: 36 Lectures

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
Upon completion of this course, students will be able to,
CO-1: Acquire thorough understanding of work and energy concepts in various mechanical systems.
CO-2:. *Understand the analogy and differences between translational and rotational dynamics, and application of both motions.*
CO-3: Apply Kepler's laws to describe the motion of planets and satellite in circular orbit.
CO-4: *Learn inertial and non-inertial frames and concept of Galilean invariance.*
CO-5: Apply Lorentz transformations to describe simultaneity, time dilation and length contraction
CO-6: Illustrate the special theory of relativity and its effects on mass and energy of a moving object.

Unit 1:
Dynamics of a system of particles. Principle of conservation of momentum. Impulse. **(2L)**
Work and Kinetic Energy Theorem. Conservative forces and examples (Gravitational and electrostatic), non-conservative forces and examples (velocity dependent forces e.g. frictional force, magnetic force). Potential Energy. Energy diagram. Stable, unstable and neutral equilibrium. Force as gradient of the potential energy. **(4 L)**

Collisions: Elastic and inelastic collisions between two spherical bodies. Kinematics of $2 \rightarrow 2$ scattering in Centre of Mass and Laboratory frames. **(2L)**

Unit-2:

Angular momentum of a particle and system of particles. Torque. Principle of conservation of angular momentum. Rotation about a fixed axis. Determination of moment of inertia of symmetric rigid bodies (rectangular, cylindrical and spherical) using parallel and perpendicular axes theorems. Kinetic energy of rotation. Motion involving both translation and rotation. **(5L)**

Non-Inertial Systems: Non-inertial frames and fictitious forces. Uniformly rotating frame. Centrifugal force. Coriolis force and its applications. **(4L)**

Unit-3

Central forces, Law of conservation of angular momentum for central forces, Two-body problem and its reduction to equivalent one-body problem and its solution. Concept of effective potential energy and stability of orbits for central potentials of the form kr^n for n = 2 and -1 using energy diagram, discussion on trajectories for n = -2. Solution of the Kepler Problem, Kepler's Laws for planetary motion, orbit for artificial satellites **(8L)**

Unit 4

Special Theory of Relativity

Inertial and Non-inertial frames, Invariance of Newton's Laws of motion under Galilean transformations. **(2L)**

Postulates of Special Theory of Relativity, Lorentz Transformations, simultaneity, length contraction, time dilation, proper length and proper time, life time of a relativistic particle (for example muon decay time and decay length), relativistic transformation of velocity and acceleration, variation of mass with velocity, mass-energy equivalence. **(9L)**

Reference Books:

1. Introduction to Classical Mechanics, R. G. Takwale, P. S. Puranik, Tata McGraw-Hill.
2. Engineering Physics, H.K. Malik, A. K. Singh, Tata McGraw-Hill.
3. An introduction to Mechanics, D. Kleppner, R.J. Kolenkow, McGraw-Hill.
4. Mechanics, Berkeley Physics, vol.1, C. Kittel, W. Knight, et.al., Tata McGraw-Hill.
5. Fundamentals of Physics, R. Resnick, D. Halliday and J. Walker, Wiley Publications.
6. Feynman Lecture Series, Vol.I, R.P.Feynman, R.B.Leighton, M.Sands, Pearson Education
7. Mechanics, D.S. Mathur, S. Chand and Company Limited.
8. 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 BPH23-102T

Course Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PO13**	**PO14**	**PO15**	**PSO1**	**PSO2**	**PSO3**
CO-1	3	3	3	3	3	2	2	3	3	3	2	-	3	2	3	3	3	2
CO-2	3	3	3	3	3	2	3	3	3	3	3	-	2	3	3	3	3	3
CO-3	3	3	3	3	2	2	2	3	3	3	3	-	1	2	3	3	3	3
CO-4	3	3	2	3	3	2	3	3	3	2	2	-	2	1	3	3	3	3
CO-5	3	3	3	3	2	1	3	3	3	2	2	-	2	2	3	3	3	3
CO-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: BPH23-102P
SUBJECT NAME: MECHANICS LAB
NO. OF CREDITS: 1

			SESSIONAL	: 15
L	T	P	FINAL EXAM	: 35
0	0	2	TOTAL	: 50

Select at least 06 experiments from the following

1. Measurements of length (or diameter) using vernier caliper, screw gauge and travelling microscope.
2. To Study the random error in observations.
3. To determine the height of a building using a Sextant.
4. To determine the vertical distance between two given points using sextant.
5. To determine the Moment of Inertia of a Flywheel.
6. To determine **g** and velocity for a freely falling body using Digital Timing Technique
7. To determine the Young's Modulus of a Wire by Optical Lever Method.
8. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
9. To determine the elastic Constants of a wire by Searle's method.

Reference Books

1. Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. BSc Practical Physics, Harnam Singh, S. Chand Publications, 2020.
3. BSc Practical Physics, Geeta Sanon, R. Chand Publications, 2020.
4. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
5. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Edn, 1511, Kitab Mahal.
6. Engineering Physics, H.K. Malik, A. K. Singh, Tata McGraw-Hill.

SUGGESTED WEB SOURCES:

1. Virtual Labs (vlab.co.in)

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

B.Sc. (H) PHYSICS SEMESTER I
CODE: BPH23-103T
SUBJECT NAME: Waves and Oscillations
NO. OF CREDITS: 3

			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
3	0	0	TOTAL	: 100

Total: 36 Lectures

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

On successful completion of this course, the students will have the skill and knowledge to,
CO-1: Understand simple harmonic motion
CO-2: Understand superposition of N collinear harmonic oscillations
CO-3: Understand superposition of two perpendicular harmonic oscillations
CO-4: Understand free, damped and forced oscillations
CO-5: Understand coupled oscillators and normal modes of oscillations
CO-6: Understand travelling and standing waves, stretched strings

Unit 1: Simple Harmonic Motion (13 Hours)

Differential equation of simple harmonic oscillator, its solution and characteristics, energy in simple harmonic motion, linearity and superposition principle, motion of simple and compound pendulum (Bar and Kater's pendulum), loaded spring.

Superposition of N collinear harmonic oscillations with (1) equal phase differences and (2) equal frequency differences, Beats
Superposition of two perpendicular harmonic oscillations: Graphical and Analytical Methods. Lissajous Figures with equal and unequal frequencies, effect of variation of phase

Unit 2: Damped and Forced Oscillations (9 Hours)
Damped Oscillations: Equation of motion, dead beat motion, critically damped system, lightly damped system: relaxation time, logarithmic decrement, quality factor
Forced Oscillations: Equation of motion, complete solution, steady state solution, resonance, sharpness of resonance, power dissipation, quality factor

Unit 3: Coupled Oscillations (8 Hours)
Coupled oscillators, normal coordinates and normal modes, energy relation and energy transfer, di-atomic molecules, representation of a general solution as a linear sum of normal modes, normal modes of N coupled oscillators.

Unit 4: Wave Motion (6 Hours)
One dimensional plane wave, classical wave equation, standing wave on a stretched string (both ends fixed), normal modes. Travelling wave solution

Essential Readings:
FOR THEORY COMPONENT
1) Vibrations and Waves by A. P. French. (CBS Pub. and Dist., 1987)

2) The Physics of Waves and Oscillations by N.K. Bajaj (Tata McGraw-Hill, 1988)
3) Fundamentals of Waves and Oscillations By K. Uno Ingard (Cambridge University Press, 1988)
4) An Introduction to Mechanics by Daniel Kleppner, Robert J. Kolenkow (McGraw-Hill, 1973)
5) Waves: BERKELEY PHYSICS COURSE by Franks Crawford (Tata McGrawHill, 2007).
6) Classical Mechanics by Peter Dourmashkin, John Wiley and Sons
7) https://phys.libretexts.org/Bookshelves/Classical_Mechanics/classical_Mechanics_(Dour mashkin)
Suggestive Readings:
1) Fundamentals of Physics, Resnick, Halliday and Walker 10/e, 2013, Wiley.
2) Feynman Lectures, Vol. 1, R. P. Feynman, R. B. Leighton, M. Sands, 2008, Pearson Education.
3) University Physics, H. D. Young, R. A. Freedman, 14/e, 2015, Pearson Education.

Mapping of CO and PO for BPH23-103T

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
CO-1	3	3	3	3	3	2	2	3	3	3	2	-	3	2	3	3	3	2
CO-2	3	3	3	3	3	2	3	3	3	3	3	-	2	3	3	3	3	3
CO-3	3	3	3	3	2	2	2	3	3	3	3	-	1	2	3	3	3	3
CO-4	3	3	2	3	3	2	3	3	3	2	2	-	2	1	3	3	3	3
CO-5	3	3	3	3	2	1	3	3	3	2	2	-	2	2	3	3	3	3
CO-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: BPH23-103P
SUBJECT NAME: Waves and Oscillations Lab
NO. OF CREDITS: 1

			SESSIONAL	: 15
L	T	P	FINAL EXAM	: 35
0	0	2	TOTAL	: 50

Total: 30 periods

Every student must perform at least 5 experiments

1) Experiments using bar pendulum:

- **a)** Estimate limits on angular displacement for SHM by measuring the time period at different angular displacements and compare it with the expected value of time period for SHM.
- **b)** Determine the value of g using bar pendulum.
- **c)** To study damped oscillations using bar pendulum
- **d)** Study the effect of area of the damper on damped oscillations. Plot amplitude as a function of time and determine the damping coefficient and Q factor for different dampers.

2) To determine the value of acceleration due to gravity using Kater's pendulum for both the cases (a) $T_1 \approx T_2$ and (b) $T_1 \neq T_2$ and discuss the relative merits of both cases by estimation of error in the two cases.
3) Understand the applications of CRO by measuring voltage and time period of a periodic waveform using CRO. And study the superposition of two perpendicular simple harmonic oscillations using CRO (Lissajous figures)
4) Experiments with spring and mass system:

- **a)** To calculate g, spring constant and mass of a spring using static and dynamic methods.
- **b)** To calculate spring constant of series and parallel combination of two springs.

5) To study normal modes and beats in coupled pendulums or coupled springs.
6) To determine the frequency of an electrically maintained tuning fork by Melde's experiment and to verify $\lambda^2 - T$ Law.
7) To determine the current amplitude and phase response of a driven series LCR circuit with driving frequency and resistance. Draw resonance curves and find quality factor for low and high damping.

References (For Laboratory Work):

1) Advanced Practical Physics for students, B. L. Flint and H. T. Worsnop, 1971, Asia Publishing House.
2) Engineering Practical Physics, S. Panigrahi and B. Mallick, 2015, Cengage Learning India Pvt. Ltd.
3) Practical Physics, G. L. Squires, 2015, 4/e, Cambridge University Press.
4) A Text Book of Practical Physics, Vol I and II, Prakash and Ramakrishna, 11/e, 2011, Kitab Mahal.
5) An Introduction to Error Analysis: The study of uncertainties in Physical Measurements, J. R. Taylor, 1997, University Science Books List of experiments

Multi Discipline Courses (MDC)

B.Sc. (H) PHYSICS SEMESTER I
CODE: OMTHP23-101
SUBJECT NAME: BASIC CALCULUS
NO. OF CREDITS: 3

		SESSIONAL	: 25
L	P	FINAL EXAM	: 75
3	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:

CO-1: *Acquire knowledge about differential calculus.*
CO-2: Learn about partial differentiation and maxima-minima of functions of two variables.
CO-3: Understand about integral calculus: single integral and double integral.
CO-4: Solve problems on triple integral and beta and gamma functions.

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.

UNIT II

Functions of two or more variables, Partial derivatives of first and second order, Total differential and differentiability, Euler's theorem for Homogeneous functions, Derivatives of Composite and Implicit functions, Jacobians.

UNIT III

Applications of Single integration to find volume of solids and surface area of solids by revolution, Double integral, Applications of double integral to find Area enclosed by plane curves.

UNIT IV

Triple Integral, curvilinear coordinates, Beta & Gamma functions.

Reference Books:

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

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 MATH23P-101

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

Multi Discipline Courses (MDC)

B.Sc. (H) PHYSICS SEMESTER I
CODE: OEC-CE-1011
SUBJECT NAME: Fundamentals of Programming
NO. OF CREDITS: 2

		SESSIONAL	: 25
L	P	FINAL EXAM	: 75
2	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 the course, students will be able to
CO1: Differentiate between Procedure-Oriented programming and Object-Oriented programming
CO2: Have understanding the syntax of the language
CO3: Implement various object oriented features like inheritance, data abstraction encapsulation and polymorphism to solve various computing problems using C++ language

CO4: 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).

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).

UNIT-III 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).

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,. Inheritance and Polymorphism: Introduction to Inheritance and Polymorphism.

REFERENCE BOOKS

1. E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill.
2. Sharma A. K., “Computer Fundamentals and Programming in C “, 2018
3. Kanetkar Yashavant P. ,”Let us C”, BPB Publications, 2010.
4. Herbtz Schildt, "C++: The Complete Reference", Fourth Edition, McGraw Hill, 2017.
5. E. Balaguruswamy, "Object Oriented Programming with C++", Tata McGraw-Hill Education, 2008.
6. Paul Deitel, Harvey Deitel, "C++ How to Program", 8th Edition, Prentice Hall, 2011.

Mapping of CO and PO for OCSC23-101T

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

CO-3	3	-	3	3	3	3	-	3	-	2	2	-	-	-	-	2	2	-
CO-4	3	1	3	3	3	3	1	3	1	2	2	-	2	1	1	2	3	-

B.Sc. (H) PHYSICS SEMESTER I
CODE: OEC-CE-1012
SUBJECT NAME: Fundamentals of Programming Lab
NO. OF CREDITS: 1

		SESSIONAL	: 15
L	P	FINAL EXAM	: 35
0	1	TOTAL	: 50

Every student has to perform the following programs in C/C++

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.

Multi Discipline Courses (MDC)

B.Sc. (H) PHYSICS SEMESTER I
CODE: OCHP23-101
SUBJECT NAME: INORGANIC CHEMISTRY-I
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

CO-1: *Solve the conceptual questions based on the quantum mechanical model of the atom.*

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

CO-3: Understand the concept of lattice energy using Born-Landé equation.

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. (15 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^+. (15 L)

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.

B.Sc. (H) PHYSICS SEMESTER I
CODE: OCHP23-102
SUBJECT NAME: INORGANIC CHEMISTRY-I LAB
NO. OF CREDITS: 1

			SESSIONAL	: 15
L	T	P	FINAL EXAM	: 35
0	0	2	TOTAL	: 50

The students have to perform at least 5 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 Fe^{2+} , $C_2O_4^{2-}$ (using $KMnO_4$, $K_2Cr_2O_7$)
   - Iodometric titrations: Determination of Cu^{2+} (using standard hypo solution).
   - Complexometric titrations: Determination of Mg^{2+} , Zn^{2+} by EDTA.

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.

Skill Enhancement Course in Physics (SECP)

B.Sc. (H) PHYSICS SEMESTER-I
CODE: SECP23-101T
SUBJECT NAME: Computational Skills with C++
NO. OF CREDITS: 2

L	T	P
2	0	0

SESSIONAL : 25
FINAL EXAM : 75
TOTAL : 100

Total: 24 Lectures

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 the course, students will be able to
CO1: Prepare algorithms and flowcharts for solving a problem.
CO2: Have understanding the syntax of C++ programming language like headers, data types, operators etc.

CO-3: Learn various control statements in C++ and apply them to solve problems.

CO-4: Learn various Functions in C++ and apply them to solve problems.

CO-5: Learn various 1-D and 2-D arrays in C++ and apply them to solve problems.

Unit- 1

Basics of scientific computing (Mandatory):

(a) Binary and decimal arithmetic, Floating point numbers, single and double precision arithmetic, underflow and overflow, numerical errors of elementary floating point operations, round off and truncation errors with examples.

(b) Introduction to Algorithms and Flow charts. Branching with examples of conditional statements, for and while loops. **(3L)**

Introduction to C++: Basic idea of Compilers. Structured programming. Idea of Headers, Data Types, Enumerated Data, Conversion and casting, constants and variables, Mathematical, Relational, Logical and Bit wise Operators. Precedence of Operators, Expressions and Statements, Scope and Visibility of Data, block, Local and Global variables, Auto, static and External variables. Input and output statements. I/O manipulations, iostream and cmath header files, using namespace. **(5L)**

Unit- 2

Control Statements: The if-statement, if-else statement, Nested if Structure, If -Else if –else block, Ternary operator, Goto statement, switch statement, Unconditional and Conditional looping, While loop, Do-while loop, For loop, nested loops, break and continue statements. Simple programs for practice like solving quadratic equations, temperature conversion etc. **(5L)**

Unit- 3

Functions: Inbuilt functions. User-defined functions, function declaration, function definition, function prototype, void functions and function arguments, return statement. Local and global variables. The main function. Passing parameter by value and by reference. Inline functions. Function overloading. Writing functions to perform simple operations like finding largest of three numbers, listing prime numbers etc., Generating pseudo random numbers. **(5L)**

Unit-4

Arrays: Array definition, passing arrays to functions, Finding sum, maximum, minimum, mean and variance of given array. 2-d arrays, matrix operations (sum, product, transpose etc). Saving data generated by a C++ program in a file. (6 L)

References:

1. Sharma A. K., “Computer Fundamentals and Programming in C “, 2018
2. Kanetkar Yashavant P. ,”Let us C”, BPB Publications, 2010.
3. Herbtz Schildt, "C++: The Complete Reference", Fourth Edition, McGraw Hill, 2017.
4. E. Balaguruswamy, "Object Oriented Programming with C++", Tata McGraw-Hill Education, 2008.
5. Paul Deitel, Harvey Deitel, "C++ How to Program", 8th Edition, Prentice Hall, 2011.

Mapping of CO and PO for SECP23-101T

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
CO-1	3	1	3	3	3	3	1	2	1	2	2	-	2	1	1	3	3	2
CO-2	3	-	2	2	2	3	-	2	-	-	-	-	-	-	-	3	3	2
CO-3	3	-	3	3	3	3	-	3	-	-	1	-	-	-	-	3	3	2
CO-4	3	2	3	3	3	3	1	3	1	2	2	-	2	2	1	3	3	2
CO-5	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 I
CODE: SECP23-101P
SUBJECT NAME: Computational Skills with C++ Lab
NO. OF CREDITS: 1

L	T	P		
0	0	2	SESSIONAL	: 15
			FINAL EXAM	: 35
			TOTAL	: 50

1. Generate the Fibonacci series up to the given limit N and also print the number of elements in the series.
2. Find minimum and maximum of N numbers.
3. Find the GCD of two integer numbers.
4. Calculate factorial of a given number.
5. Find all the roots of a quadratic equation $Ax^2 + Bx + C = 0$ for non – zero coefficients A, B and C. Else report error.
6. Calculate the value of sin (x) and cos (x) using the series. Also print sin (x) and cos (x) value using library function.
7. Generate and print prime numbers up to an integer N.
8. Sort given N numbers in ascending order.
9. Find the sum & difference of two matrices of order MxN and PxQ.
10. Find the product of two matrices of order MxN and PxQ.
11. Find the transpose of given MxN matrix.
12. Find the sum of principle and secondary diagonal elements of the given MxN matrix.

Recommended List of Programs

Section-I (At least Two)
(a) Make a function that takes a number N as input and returns the value of factorial of N. Use this function to print the number of ways a set of m red and n blue balls can be arranged.

(b) Generate random numbers (integers and floats) in a given range and calculate area and volume of regular shapes with random dimensions.

(c) Generate data for coordinates of a projectile and plot the trajectory. Determine the range, maximum height and time of flight for a projectile motion.

Section-II (At least Three)

(a) To plot the displacement-time and velocity-time graph for the un-damped, under-damped critically damped and over-damped oscillator using Gnuplot using given formulae.

(b) To compute the left, right and central approximations for derivative of a function given in closed form. Plot both the function and derivative on the same graph. Plot (using Gnuplot) the error as a function of step size on a log-log graph, study the behaviour of the plot as step size decreases and hence discuss the effect of round off error.

(c) To generate array of N random numbers drawn from a given distribution (uniform, binomial, poisson and gaussian) and plot them using Gnuplot for increasing N to verify the distribution. Verify the central limit theorem.

(d) To implement the transformation of physical observables under Galilean, Lorentz and Rotation transformation

Section-III (At least one)

(a) To find value of and to integrate a given function using acceptance-rejection method.

(b) To perform linear fitting of data using the inbuilt function scipy.stats.linregress using Gnuplot. Plot the data points and the fitted line on the same graph.

References:

1. Sharma A. K., “Computer Fundamentals and Programming in C “, 2018
2. Kanetkar Yashavant P. ,”Let us C”, BPB Publications, 2010.
3. Herbtz Schildt, "C++: The Complete Reference", Fourth Edition, McGraw Hill, 2017.
4. E. Balaguruswamy, "Object Oriented Programming with C++", Tata McGraw-Hill Education, 2008.
5. Paul Deitel, Harvey Deitel, "C++ How to Program", 8th Edition, Prentice Hall, 2011.

B.Sc. (H) PHYSICS SEMESTER III&IV
CODE: SECP23-102T
SUBJECT NAME: BASIC INSTRUMENTATION 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:

CO-1: *Learn the necessary working knowledge on accuracy, precision, resolution, range and errors/uncertainty in measurements*

CO-2: Gain knowledge on the working and operations of multimeter.

CO-3: Understand about digital instruments like voltmeter and milivoltmeter.

CO-4: Understand the working, theory and applications of CRO for measurements.

CO-5: Understand the concept of impedance bridges and Q-meters.

CO-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. (7 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. (7 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/

Mapping of CO and PO for SECP23-102T

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
CO-1	3	1	3	3	1	3	-	2	-	-	-	-	-	-	2	3	3	3
CO-2	3	-	3	3	1	2	-	2	1	2	1	-	-	-	1	3	3	3
CO-3	3	-	2	2	2	2	-	2	1	1	-	-	-	-	1	3	3	3
CO-4	3	-	2	1	1	1	-	1	1	2	-	-	-	-	0	3	3	3
CO-5	3	-	2	2	-	1	-	1	-	-	-	-	-	-	1	3	3	3
CO-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: SECP23-102P
SUBJECT NAME: BASIC INSTRUMENTATION SKILLS LAB
NO. OF CREDITS: 1

			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:

CO-1: *Learn the loading effect of a multimeter while measuring voltage across a low resistance and high resistance.*

CO-2: *Measure Q of a coil and its dependence on frequency, using a Q- meter.*

CO-3: *Observe waveforms on the C.R.O. and to measure amplitude and frequency of the waveforms.*

CO-4: *Study variation in current and voltage in a series and parallel LCR.*

CO-5: *Measurement of R, L and C using a LCR bridge.*

CO-6: *Understand distortion of a RF signal generator using distortion factor meter.*

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)

Ability Enhancement Compulsory Course (AECC)

B.Sc. (H) PHYSICS SEMESTER-I
CODE: AEC-101-N1
SUBJECT NAME: Writing Skills and the Art of Rhetoric **(WSAAR)**
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 Objectives: 1. To help students define, describe and articulate better. 2.To introduce students to the art of rhetoric. 3. To familiarize students with select genres of creative writing. 4. To guide students towards application of the techniques they have learnt.

Course Outcomes:

CO1: Students will be able to define, describe and articulate better.
CO2: Students will learn the art of rhetoric.
CO3: Students will be practising writing in select genres of creative writing.
CO4: Students will be able to apply the techniques they have learnt.

Unit-I: Narration and Writing: Define, Describe, Narrate and Argue; Articulating Questions and Innovative Thoughts; Narration: chronological order and achronological order; first-person, second-person and third person point of view in narration; key elements: plot, character, pov, setting and conflict; Storytelling, event news stories and Corporate Storytelling; problem-solution structures.

Exercise: *Ekphrasis*, Pictures: Describing scenes; Creating Stories out of words and pictures.

Unit-II: Reasoning and Rhetoric: Rhetoric, the art of persuasion; *ethos, logos* and *pathos*, Aristotle's triangle; Freytag's pyramid; reasoning; organizing; articulating; Synthesis; *Antanagoge; Hypophora.*
Recognize and evaluate the strength of an argument and its impact.

Exercise: Rhetorical and Oratorical Skills: Techniques for effective public speaking, both prepared and extemporaneous; Brainstorm ideas for your own short speech.

Unit-III: Writing Features and Articles: Writing Features and Articles, , Op-Eds (Opinions and Editorials), Features; Articles; Topical Issues, Memes; Backgrounders; Memes; Idioms, Proverbs; Using Literary Devices and Figurative Language.

Exercises: Building Memes and Feature Writing

Unit: IV: Performance and Drills: Reading Drills; Speaking Drills; Team-Performance Drills; Solo Performance Drills; Apply the elements of rhetoric you have learned so far in the final draft of your op-ed and discussion.

Suggested Readings:

1. Aspects of the Novel by E.M.Forster
2. The Rhetoric of Fiction by Wayne C Booth.
3. The Art of Rhetoric by Aristotle.
4. Writing Guide with Handbook by Michelle Bachelor Robinson, Spelman College Maria Jerskey.
5. The Oxford Essential Guide to Writing by Thomas S. Kane.

SUGGESTED WEB SOURCES:

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

Value Added Course (VAC)

B.Sc. (H) Physics SEMESTER- I

Subject Name: Environmental Studies-I (EVS-I)

SUBJECT CODE: VAC-101-N1

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

NOTE: Question paper will have two parts. Part-1 will be compulsory and have 10 questions of equal marks covering the entire syllabus. Attempt any four questions out of six from Part-2.

COURSE OUTCOMES:

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

CO1: Understand human interaction with the environment and efforts taken at international level to protect and conserve environment.

CO2: Understand concept of natural resources, their distribution, conservation, management and sustainable utilization.

CO3: Develop critical thinking towards local, regional and global environmental issue.

CO4: Describe the concept of ecosystem, biodiversity and their conservation.

Unit I: Humans and the Environment (6 hrs)

The man-environment interaction: Humans as hunter-gatherers; Mastery of fire; Origin of agriculture; Emergence of city-states; Great ancient civilizations and the environment, Indic Knowledge and Culture of sustainability; Middle Ages and Renaissance; Industrial revolution and its impact on the environment; Population growth and natural resource exploitation; Global environmental change. *Environmental Ethics and emergence of environmentalism:* Anthropocentric and eco-centric perspectives (Major thinkers); The Club of Rome- Limits to Growth; UN Conference on Human Environment 1972; World Commission on Environment and Development and the concept of sustainable development; Rio Summit and subsequent international efforts.

Unit II: Natural Resources and Sustainable Development (6 hrs)

Overview of natural resources: Definition of resource; Classification of natural resources- biotic and abiotic, renewable and non-renewable.

Biotic resources: Major type of biotic resources- forests, grasslands, wetlands, wildlife and aquatic (fresh water and marine); Microbes as a resource; Status and challenges.

Water resources: Types of water resources- fresh water and marine resources; Availability and use of water resources; Environmental impact of over-exploitation, issues and challenges; Water scarcity and stress; Conflicts over water.

Soil and mineral resources: Important minerals; Mineral exploitation; Environmental problems due to extraction of minerals and use; Soil as a resource and its degradation.

Energy resources: Sources of energy and their classification, renewable and non-renewable sources of energy; Conventional energy sources- coal, oil, natural gas, nuclear energy; non-conventional energy sources- solar, wind, tidal, hydro, wave, ocean thermal, geothermal, biomass, hydrogen and fuel cells; Implications of energy use on the environment.
Introduction to sustainable development: Sustainable Development Goals (SDGs)- targets and indicators, challenges and strategies for SDGs.

Unit III: Environmental Issues: Local, Regional and Global (6 hrs)
Environmental issues and scales: Concepts of micro-, meso-, synoptic and planetary scales; Temporal and spatial extents of local, regional, and global phenomena.
Pollution: Impact of sectoral processes on Environment; Types of Pollution- air, noise, water, soil, thermal, radioactive; municipal solid waste, hazardous waste; transboundary air pollution; acid rain; smog.
Land use and Land cover change: land degradation, deforestation, desertification, urbanization.
Biodiversity loss: past and current trends, impact.
Global change: Ozone layer depletion; Climate change. Disasters – Natural and Man-made (Anthropogenic)

Unit IV: Conservation of Biodiversity and Ecosystems (6 hrs)
Biodiversity and its distribution: Biodiversity as a natural resource; Levels and types of biodiversity; Biodiversity in India and the world; Biodiversity hotspots; Species and ecosystem threat categories.
Ecosystems and ecosystem services: Major ecosystem types in India and their basic characteristics-forests, wetlands, grasslands, agriculture, coastal and marine; Ecosystem services- classification and their significance.
Threats to biodiversity and ecosystems: Land use and land cover change; Commercial exploitation of species; Invasive species; Fire, disasters and climate change. Major conservation policies: in-situ and ex-situ conservation approaches; Major protected areas; National and International Instruments for biodiversity conservation; the role of traditional knowledge, community-based conservation; Gender and conservation.
Field Work (6 hrs)

The students are expected to be engaged in some of the following or similar identified activities:

a) Field visits to identify local/regional environmental issues, make observations including data collection and prepare a brief report.
b) Discussion on one national and one international case study related to the environment and sustainable development.
c) Participation in plantation drive and nature camps.
d) Documentation of campus flora and fauna.

Suggested Readings:

1. Chiras, D. D and Reganold, J. P. (2010). Natural Resource Conservation: Management for a Sustainable Future.10th edition, Upper Saddle River, N. J. Benjamin/Cummins/Pearson.
2. Gilbert M. Masters and W. P. (2008). An Introduction to Environmental Engineering and Science, Ela Publisher (Pearson)
3. Kaushik, A., & Kaushik, C. P. (2006). Perspectives in environmental studies. New Age International.
4. Sharma, P. D., & Sharma, P. D. (2012). Ecology and environment. Rastogi Publications.
5. William P. Cunningham and Mary A. (2015). Cunningham Environmental Science: A global concern, Publisher (Mc-Graw Hill, USA)

Syllabus of B.Sc. (H) Physics

Semester II

Discipline Core Course (DCC)

B.Sc. (H) PHYSICS SEMESTER II

CODE: BPH23-201T

SUBJECT NAME: MATHEMATICAL PHYSICS-II

NO. OF CREDITS: 3

			SESSIONAL	: 25
L	**T**	**P**	**FINAL EXAM**	**: 75**
3	**0**	**0**	**TOTAL**	**: 100**

Total: 36 Lectures

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 completing this course, student will be able to,

CO-1: Use curvilinear coordinates to solve problems with spherical and cylindrical symmetries

CO-2: Learn about gamma and beta functions and their applications

CO-3: Represent a periodic function by a sum of harmonics using Fourier series

CO-4: Obtain power series solution of differential equation of second order with variable coefficient using Frobenius method

CO-5: Understand the properties and applications of Legendre polynomials

UNIT – 1

Orthogonal Curvilinear Coordinates: Orthogonal Curvilinear Coordinates. Scale factors, element of area and volume in spherical and cylindrical coordinate Systems. Derivation of Gradient, Divergence, Curl and Laplacian in Spherical and Cylindrical Coordinate Systems. **(8L)**

Unit-2

Some Special Integrals: Beta and Gamma Functions and relation between them, Recursion relation of Gamma Functions; Gamma function of negative numbers Expression of Integrals in terms of Gamma and Beta Functions. (6L)

Unit-3

Fourier Series: Periodic functions, Orthogonality of sine and cosine functions, Convergence of Fourier series and 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 (Fourier Cosine Series and Fourier Sine Series), Parseval's Identity.

Dirac Delta function: Definition and properties of Dirac delta function and simple examples. (10L)

Unit-4

Frobenius Method and series solution of Differential Equations: Singular Points of Second Order Linear Differential Equations and their importance, Application of Frobenius method for finding series solution. (3L)

Legendre Differential Equations and its solution. Properties of Legendre Polynomials: Rodrigues Formula, Generating Function, Orthogonality of Legendre Polynomials, Simple recurrence relations, Expansion of function in a series of Legendre Polynomials. Associated Legendre's polynomials.

Spherical harmonics. Addition theorem for spherical harmonics, recurrence relations for spherical harmonics. (9L)

References:

Essential Readings:

1. Mathematical Methods for Scientists and Engineers, D. A. McQuarrie, 2003, Viva Book.
2. Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
3. Mathematical Physics, H. K. Das, S. Chand Publications.
4. Mathematical Physics, B.S. Rajput, Pragati Prakashan, Meerut.
5. Vector Analysis and Cartesian Tensors, D. E. Bourne and P. C. Kendall, 3 Ed., 2017, CRC Press.
6. Vector Analysis, Murray Spiegel, 2nd Ed., 2017, Schaum's Outlines Series.
7. Fourier analysis: With Applications to Boundary Value Problems, Murray Spiegel, 2017, McGraw Hill Education.
8. Mathematical Methods for Physicists, G. B. Arfken, H. J. Weber, F. E. Harris, 7 Ed., 2013, Elsevier.

Additional Readings:

1) Introduction to Electrodynamics, Chapter 1, David J. Griffiths, 4 Ed., 2017, Cambridge University Press.
2) The Feynman Lectures on Physics, Volume II, Feynman, Leighton and Sands, 2008, Narosa Publishing House.
3) Introduction to Vector Analysis, Davis and Snider, 6 Ed., 1990, McGraw Hill.
4) Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.

Mapping of CO and PO for BPH23-201T

Course Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PO13**	**PO14**	**PO15**	**PSO1**	**PSO2**	**PSO3**
CO-1	3	-	2	2	2	3	-	1	1	-	-	-	-	-	-	3	2	1
CO-2	3	-	3	3	3	3	-	2	1	-	2	-	-	-	-	3	3	2
CO-3	3	1	3	3	3	3	1	3	1	2	2	-	2	-	1	3	3	2
CO-4	3	-	2	2	2	3	-	1	1	-	1	-	-	-	-	3	2	1
CO-5	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 IV
CODE: BPH23-201P
SUBJECT NAME: MATHEMATICAL PHYSICS-II LAB
NO. OF CREDITS: 1

			SESSIONAL	: 15
L	T	P	FINAL EXAM	: 35
0	0	2	TOTAL	: 50

At least 6 experiments from the following:

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,
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

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

1. Solve differential equations:

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

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

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

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

2. Dirac Delta Function:

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

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.*

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.

B.Sc. (H) PHYSICS SEMESTER-II
CODE: BPH23-202T
SUBJECT NAME: ELECTRICITY AND MAGNETISM
NO. OF CREDITS: 3

			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
3	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:

CO-1: *Learn the concepts of electrostatic fields and potentials.*

CO-2: Analyze the problems of electrostatics in various systems and in matter.

CO-3: Learn the concepts of magnetostatic fields in various systems and in matter.

CO-4: Expertise the behaviour of dielectrics and magnetic materials in the presence of external electric fields and magnetic fields respectively.

CO-5: Understand the concept of electromagnetic induction and Maxwell's electromagnetic theory.

UNIT – I (9 L)
Electric Field and Electric Potential for continuous charge distributions: Electric field due to a line charge, surface charge and volume charge, Divergence of electric field using the Dirac Delta function, Curl of electric field, Electric field vector as negative gradient of scalar potential, Ambiguities of electric potential, Differential and integral forms of Gauss's Law, Application of Gauss's law to various charge distributions having spherical, cylindrical and planar symmetries.

Unit-II (9L)
Boundary Value Problems in Electrostatics: Laplace's and Poisson equations, First and second uniqueness theorems, Electrostatic boundary conditions for conductors and capacitors.
Special techniques for the calculation of Potential and Field: The Method of Images is applied to a system of a point charge and finite continuous charge distribution (line charge and surface charge) in the presence of (i) a plane infinite sheet maintained at constant potential, and (ii) a sphere maintained at constant potential.
Electric Field in Matter: Polarization in matter, Bound charges and their physical interpretation, Field inside a dielectric, Displacement vector **D**, Gauss' law in the presence of dielectrics, Boundary conditions for **D**, Linear dielectrics, electric susceptibility and dielectric constant.

UNIT – III (9 L)
Magnetic Field: Divergence and curl of magnetic field **B**, Magnetic field due to arbitrary current distribution using Biot-Savart law, Integral and differential forms of Ampere's law and its applications for symmetrical current distributions, Vector potential and its ambiguities, Coulomb gauge and

possibility of making vector potential divergence less, Vector potential due to line, surface and volume currents using Poisson equations for components of vector potential.

Unit-IV (9L)

Magnetic Properties of Matter: Magnetization vector, Bound currents, Magnetic intensity, Differential and integral form of Ampere's Law in the presence of magnetised materials, Magnetic susceptibility and permeability of diamagnetic, paramagnetic and ferromagnetic materials.

Electrodynamics: Faraday's law, Lenz's law, Inductance and electromotive force, Ohm's law ($\vec{J}=\sigma E$), Energy stored in a magnetic field, Continuity equation, Displacement current and displacement current density, Basic introduction to Maxwell's equations in electromagnetism.

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. Engineering Physics, H.K. Malik, A. K. Singh, Tata McGraw-Hill.
4. Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn., 1998, Benjamin Cummings.
5. Feynman Lectures Vol.2, R.P.Feynman, R.B.Leighton, M.Sands, 1508, Pearson Education
6. 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/

Mapping of CO and PO for BPH23-202T

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
CO-1	3	3	3	3	3	3	2	3	2	2	2	-	3	-	2	2	2	2
CO-2	3	3	3	3	3	2	2	3	2	3	3	-	2	-	2	2	2	3
CO-3	3	3	3	3	3	3	2	3	2	3	2	-	3	-	2	2	3	2
CO-4	3	3	3	3	3	2	3	3	2	2	2	-	2	-	2	2	3	2
CO-5	3	3	3	3	3	3	2	3	2	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 II
CODE: BPH23-202P
SUBJECT NAME: ELECTRICITY AND MAGNETISM LAB
NO. OF CREDITS: 1

			SESSIONAL	: 15
L	T	P	FINAL EXAM	: 35
0	0	2	TOTAL	: 50

At least 6 experiments from the following

1. To determine an unknown Low Resistance using Potentiometer.
2. To determine an unknown Low Resistance using Carey Foster's Bridge.
3. Measurement of field strength B and its variation in a solenoid (determine dB/dx)
4. To determine self-inductance of a coil by Anderson's bridge.
5. Measurement of current and charge sensitivity of ballistic galvanometer
6. Measurement of critical damping resistance of ballistic galvanometer
7. Determination of a high resistance by leakage method using ballistic galvanometer
8. To determine self-inductance of a coil by Rayleigh's method.
9. To determine the mutual inductance of two coils by Absolute method.
10. 1) Magnetic field variation along the axis of a circular coil and in a Helmholtz coil ((r>a,r=a and r<a). Here, 'a' is radius of coil and 'r' is distance between the coils).
11. **B-H** curves for soft and hard ferromagnetic materials and comparison of their coercivity, retentivity and saturation magnetization for same applied magnetic field.
12. Measurement of self-inductance of a coil by Owen's Bridge

Reference Books

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. BSc Practical Physics, Geeta Sanon, R.Chand Publications, 2020.
3. BSc Practical Physics, Harnam Singh, S. Chand Publications, 2020.
4. A Text Book of Practical Physics, I.Prakash &Ramakrishna, 11th Ed., 1511,Kitab Mahal
5. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
6. 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.

B.Sc. (H) PHYSICS SEMESTER II
CODE: BPH23-203T
SUBJECT NAME: Electrical Circuit Analysis
NO. OF CREDITS: 3

			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
3	0	0	TOTAL	: 100

Total: 36 Lectures

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:

CO-1: *Learn the concepts of basic elements and their inter-connections.*

CO-*2: Analyse the DC and AC circuits for voltage, current and power.*

CO-3: Analyse RL. RC and RCL circuits for current and voltages.

CO-4: Learn to analyse two port networks.

CO-5: Learn and apply network theorems to solve various circuit problems.

Unit 1: (9 L)
Circuit Analysis: Ideal voltage source, real voltage source, current source, Kirchhoff's current law, Kirchhoff's voltage law, node analysis, mesh analysis, Star and Delta conversion
DC Transient Analysis: Charging and discharging with initial charge in RC circuit, RL circuit with initial current, time constant, RL and RC Circuits with source.

Unit 2: (9 L)
AC Circuit Analysis: Sinusoidal voltage and current, Definitions of instantaneous, peak to peak, root mean square and average values, form factor and peak factor (for half-rectified and full-rectified sinusoidal wave, rectangular wave and triangular wave), voltage-current relationship in resistor, inductor and capacitor, phasor, complex impedance, power in AC circuits.

Unit-3: (9L)
Sinusoidal circuit analysis for RL, RC and RLC Circuits, resonance in series and parallel RLC Circuits (Frequency Response, Bandwidth, Quality Factor), selectivity, application of resonant circuits.
Two Port Networks: Impedance (Z) Parameters, Admittance (Y) Parameters, Transmission Parameters, Impedance matching

Unit-4 (9L)
Network Theorems: Principal of duality, Superposition theorem, Thevenin theorem, Norton theorem, Their applications in DC and AC circuits with more than one source, Maximum Power Transfer theorem for AC circuits, Reciprocity Theorem, Millman's Theorem, Tellegen's theorem

References:

Essential Readings:

1) Electric Circuits, S. A. Nasar, Schaum's Outline Series, Tata McGraw Hill (2004)
2) Essentials of Circuit Analysis, Robert L. Boylestad, Pearson Education (2004)
3) Electrical Circuits, M. Nahvi and J. Edminister, Schaum's Outline Series, Tata McGraw-Hill (2005)
4) Fundamentals of Electric Circuits, C. Alexander and M. Sadiku, McGraw Hill (2008)
5) Principles of Electric Circuits, Thomas L. Floyd, 9/e (2016)

Additional Readings:

1) Network analysis, M. E. Van Valkenburg, Third edition, Prentice Hall
2) Network, Lines and Fields, John D. Ryder, Pearson Ed. II, 2015.
3) Electrical Circuits, K. A. Smith and R. E. Alley, 2014, Cambridge University Press

SUGGESTED WEB SOURCES:

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

Mapping of CO and PO for BPH23-203T

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
CO-1	3	3	3	3	3	3	2	3	2	2	2	-	3	-	2	2	2	2
CO-2	3	3	3	3	3	2	2	3	2	3	3	-	2	-	2	2	2	3
CO-3	3	3	3	3	3	3	2	3	2	3	2	-	3	-	2	2	3	2
CO-4	3	3	3	3	3	2	3	3	2	2	2	-	2	-	2	2	3	2
CO-5	3	3	3	3	3	3	2	3	2	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 II
CODE: BPH23-203P
SUBJECT NAME: Electrical Circuit Analysis Lab
NO. OF CREDITS: 1

L	T	P		
0	0	2	SESSIONAL	: 15
			FINAL EXAM	: 35
			TOTAL	: 50

Total: 30 Periods

Every student must perform at least seven experiments from the following list of experiments

1) Verification of Kirchoff's Law.
2) Verification of Superposition Theorem by using DC and AC voltage source
3) Verification of Norton's theorem.
4) Verification of Thevenin's Theorem and Maximum Power Transfer Theorem by using d.c. and a.c. voltage source

5) Determination of unknown capacitance using de-Sauty's Bridge
6) Determination of time constant of RC and RL circuit
7) Study of frequency response of RC circuit
8) Study of frequency response of a parallel LCR Circuit and determination of its resonant frequency, impedance at resonance, quality factor and bandwidth.
9) Explore electrical properties of matter using Arduino:
a. To study the characteristics of a series RC Circuit.
b. To study the response curve of a series LCR circuit and determine its resonant frequency, impedance at resonance, quality factor and bandwidth.

References (for Laboratory Work):

1) A Textbook of Electrical Technology, B. L. Thareja, A. K. Thareja, Volume II, S. Chand
2) Fundamentals of Electric Circuits, C. Alexander and M. Sadiku, McGraw Hill (2008)
3) Electric Circuits, S. A. Nasar, Schaum's Outline series, Tata McGraw Hill (2004)
4) Electrical Circuits, K. A. Smith and R.E. Alley, 2014, Cambridge University Press
5) Electrical Circuit Analysis, K. Mahadevan and C. Chitran, 2nd Edition, 2018, PHI Learning Pvt. Ltd.

SKILL ENHANCEMENT COURSE

B.Sc. (H) PHYSICS SEMESTER-II
CODE: SECP23-201T
SUBJECT NAME: COMPUTATIONAL SKILLS WITH PYTHON
NO. OF CREDITS: 2

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

Total: 24 Lectures

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:

CO1: Prepare algorithms and flowcharts for solving a problem.
CO2: Have understanding the syntax of Python programming language.
CO-3: Learn various control statements in Python and apply them to solve problems.
CO-4: Learn various Functions in Python and apply them to solve problems.
CO-5: Learn NumPy fundamentals and various arrays operations in Python and apply them to solve problems.
CO-6: visualize and plot the data from the output file created by a Python programs using Matplotlib.

Unit 1

Theory of Errors: Systematic and Random Errors. Propagation of Errors. Normal Law of Errors. Standard and Probable Error. (2L)

Basic Elements of Python: Introduction To Python , The Python interpreter, the print statement, comments, Python as simple calculator, Python Data Types, Understanding Python variables, Python basic Operators, Understanding python blocks, objects and expressions, data-types and variables (numeric- int, float, complex; character and sequence types) and assignments, mathematical operators. Strings, Lists, type conversions, input statement, Formatting in the print statement. (5L)

Unit-2

Control Structures: Conditional operations, if, if-else, if-elif-else, while and for loops, indentation, break and continue, List comprehension. Simple programs for practice like solving quadratic equations, temperature conversion etc. (3L)

Functions: Inbuilt functions, user-defined functions, local and global variables, passing functions, modules, importing modules, math module, making new modules. Writing functions to perform simple operations like finding largest of three numbers, listing prime numbers, etc., Generating pseudo random numbers. (4L)

Unit 3

NumPy Fundamentals: Importing Numpy, Difference between List and NumPy array,
Adding, removing and sorting elements, creating arrays using ones(), zeros(), random(), arange(), linspace(). Basic array operations (sum, max, min, mean, variance), 2-d arrays, matrix operations, reshaping and transposing arrays, savetxt() and loadtxt(). (6L)

Unit-4

Plotting with Matplotlib: matplotlib.pyplot functions, Plotting of functions given in closed form as well as in the form of discrete data and making histograms. (4L)

Suggested Readings:

1. Head First Python, A brain friendly guide – Paul Barry, O reilly, 2nd Edition.
2. A byte of Python- C.H. Swaroop
3. Python Cookbook by David Beazley and Brian K. Jones
4. Introduction to Machine Learning with Python Paperback – by Andreas C. Muelle

Mapping of CO and PO for SECP23-201T

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2	PSO3
CO-1	3	1	3	3	3	3	1	2	1	2	2	-	2	1	1	3	3	2
CO-2	3	-	2	2	2	3	-	2	-	-	-	-	-	-	-	3	3	2
CO-3	3	-	3	3	3	3	-	3	-	-	1	-	-	-	-	3	3	2
CO-4	3	2	3	3	3	3	1	3	1	2	2	-	2	2	1	3	3	2
CO-5	3	2	3	3	3	3	2	3	1	2	2	-	2	2	1	3	3	2
CO-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: SECP23-201P
SUBJECT NAME: COMPUTATIONAL SKILLS WITH PYTHON LAB
NO. OF CREDITS: 1

			SESSIONAL	: 15
L	T	P	FINAL EXAM	: 35
0	0	2	TOTAL	: 50

Recommended List of Programs (At least Three)
(a) To plot the displacement-time and velocity-time graph for the un-damped, under-damped critically damped and over-damped oscillator using matplotlib (or Gnuplot) using given formulae.
(b) To compute the left, right and central approximations for derivative of a function given in closed form. Plot both the function and derivative on the same graph. Plot (using matplotlib/Gnuplot) the error as a function of step size on a log-log graph, study the behaviour of the plot as step size decreases and hence discuss the effect of round off error.
(c) To generate array of N random numbers drawn from a given distribution (uniform, binomial, poisson and gaussian) and plot them using matplotlib/Gnuplot for increasing N to verify the distribution. Verify the central limit theorem.
(d) To implement the transformation of physical observables under Galilean, Lorentz and Rotation transformation

Recommended List of Programs (At least one)
(a) To find value of π and to integrate a given function using acceptance-rejection method.
(b) To perform linear fitting of data using the inbuilt function scipy.stats.linregress in Python or using Gnuplot. Plot the data points and the fitted line on the same graph.

References (for Laboratory Work):
1) Documentation at the Python home page (https://docs.python.org/3/) and the tutorials there (https://docs.python.org/3/tutorial/).
2) Documentation of NumPy and Matplotlib : https://numpy.org/doc/stable/user/and https://matplotlib.org/stable/tutorials/
3) Schaum's Outline of Programming with C++, J. Hubbard, 2000, McGraw-Hill Education.
4) C++ How to Program, Paul J. Deitel and Harvey Deitel, Pearson (2016).
5) Computational Physics, Darren Walker, 1st Edn., Scientific International Pvt. Ltd (2015).
6) Elementary Numerical Analysis, K. E. Atkinson, 3rd Edn., 2007, Wiley India Edition.
7) An Introduction to Computational Physics, T. Pang, Cambridge University Press (2010).
8) Introduction to Numerical Analysis, S. S. Sastry, 5th Edn., 2012, PHI Learning Pvt. Ltd.
9) Applied numerical analysis, Cutis F. Gerald and P. O. Wheatley, Pearson Education, India (2007).

B.Sc. (H) PHYSICS SEMESTER II
CODE: SECP23-202T
SUBJECT NAME: RENEWABLE ENERGY AND ENERGY HARVESTING
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:

CO-1 *Learn the fundamentals of renewable and other alternate energy sources.*

CO-2 *Understand the principles of solar energy and its environmental impact.*

CO-3 *Learn the basics of solar energy collection and storage.*

CO-4 *Learn the basics and advances in Piezoelectric and hydroelectric energy.*

CO-5 *Study the basics of wind energy and biomass energy.*

CO-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. **(6 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.

(7 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.

(6 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.

(5 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/

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
CO-1	3	2	3	3	3	3	3	3	1	3	3	1	2	2	3	3	3	3
CO-2	3	2	3	3	3	3	3	3	1	3	3	1	2	2	3	3	3	3
CO-3	3	2	3	3	3	3	3	3	1	3	3	1	2	2	3	3	3	3
CO-4	3	2	3	3	3	3	3	3	1	3	3	1	2	2	3	3	3	3
CO-5	3	2	3	3	3	3	3	3	1	3	3	1	2	2	3	3	3	3
CO-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: SECP23-202P
SUBJECT NAME: RENEWABLE ENERGY AND ENERGY HARVESTING LAB
NO. OF CREDITS: 1

			SESSIONAL	: 15
L	T	P	FINAL EXAM	: 35
0	0	2	TOTAL	: 50

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)

Multi Discipline Courses (MDC)

B.Sc. (H) PHYSICS SEMESTER II
CODE: OMTHP23-201
SUBJECT NAME: LINEAR ALGEBRA
NO. OF CREDITS: 3

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

COURSE OUTCOMES:

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

CO-1: *Learn the Gauss–Jordan row reduction, Reduced row echelon form.*

CO-2: Locate and use information to solve problems of linear transformations and vector spaces.

CO-3: Describe the concept of linear independence, linear transformation and determinants.

CO-4: Find eigen-values and eigen-vectors and diagonalization of matrices

UNIT-I
Fundamental operation with vectors in Euclidean space $\mathbf{R}^n$, Linear combination of vectors, Triangle inequality, Matrices, Echelon matrices, Row canonical form , Row equivalence, Rank, Eigenvalues, Eigenvectors.

UNIT-II
Diagonalization of matrices, Definition and examples of vector space, Subspace, Linear independence and linear dependence of vectors, Basis and dimension of a vector space.

UNIT-III
Application of rank, Homogeneous and non-homogeneous systems of equations,
Linear transformations: Definition and examples, the matrix of a linear transformation, Kernel and range of a linear transformation.

UNIT-IV
Dimension theorem (Statement only), One to one and onto linear transformations, Invertible linear transformations, Orthogonal and orthonormal vectors, Orthogonal and orthonormal bases.

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 MATH23P-201

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

Multi Discipline Courses (MDC)

B.Sc. (H) PHYSICS SEMESTER I
CODE: OEC-CE-1013
SUBJECT NAME: Fundamentals of Database System
NO. OF CREDITS: 2

		SESSIONAL	: 25
L	P	FINAL EXAM	: 75
2	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 the course, students will be able to

CO1: Explore the basic concepts, applications and architecture of database systems
CO2: Master the basics of ER diagram
CO3: Know relational database algebra expressions and construct queries using SQL
CO4: Analyze sound design principles for logical design of databases, normalization

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

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

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

REFERENCE BOOKS

1. Fundamentals of Database Systems by R. Elmasri and S.B. Navathe, 3 rd edition, Addision-Wesley, Low Priced Edition,2000.
2. An Introduction to Database Systems by C.J. Date, 7 th edition, Addison-Wesley, Low Priced Edition, 2000.
3. Database Management and Design by G.W. Hansen and J.V. Hansen, 2 nd edition, Prentice- Hall of India, Eastern Economy Edition,1999.
4. Database Management Systems by A.K. Majumdar and P. Bhattacharyya, 5 th edition,Tata McGraw-Hill Publishing. , 1999.
5. P. Rob, C. Coronel, Database System Concepts by, Cengage Learning India, 2008.
6. R. Elmsasri,S. Navathe Fundamentals of Database Systems, Pearson Education, Fifth Edition, 2007. 9. MySQL : Reference Manual.

B.Sc. (H) PHYSICS SEMESTER I
CODE: OEC-CE-1014
SUBJECT NAME: Fundamentals of Database System Lab
NO. OF CREDITS: 1

		SESSIONAL	: 15
L	P	FINAL EXAM	: 35
0	2	TOTAL	: 50

1. Create a database having two tables with the specified fields, to computerize a library system of a Delhi University College.
   Library Books (Accession number, Title, Author, Department, Purchase Date, Price) Issued Books (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

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 (Cust ID, email, Name, Phone, Referrer ID) Bicycle (Bicycle ID, Date Purchased, Color, Cust ID, Model No) Bicycle Model (Model No, Manufacturer, Style) Service (Start Date, Bicycle ID, End Date)

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.

B.Sc. (H) PHYSICS SEMESTER II
CODE: OCHP23-201
SUBJECT NAME: INORGANIC CHEMISTRY-II
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:

CO-1: *Understanding of the bonding models, structures, reactivity's, and applications of coordination complexes, metal carbonyls, and organometallics.*

CO-2: Diagrammatically explain the working of the sodium-potassium pump in organisms and the factors affecting.

CO-3: Explain the applications of iron in biological systems with particular reference to haemoglobin, myoglobin, ferritin and transferrin

Unit I
Organometallic Compounds (15 Lectures)

Definition and Classification with appropriate examples based on nature of metal-carbon bond (ionic, s, p and multicentre bonds). Structures of methyl lithium, Zeise'ssaltandferrocene. 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).

Unit II
Bio-Inorganic Chemistry (15 Lectures)

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.

Reference Books:

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

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 OCHP23-201

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

B.Sc. (H) PHYSICS SEMESTER I
CODE: OCHP23-202
SUBJECT NAME: Inorganic Chemistry-II Lab
NO. OF CREDITS: 1

			SESSIONAL	: 15
L	T	P	FINAL EXAM	: 35
0	0	2	TOTAL	: 50

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

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

2. 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.

Ability Enhancement Compulsory Course (AECC)

B.Sc. (H) PHYSICS SEMESTER I

CODE: AEC-102-N1

SUBJECT NAME: **Communication, Mediation and Resolution (CMR)**

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 Objectives:

CO1: To orient students towards better interpersonal communication skills.
CO2: To help students adopt the habit of rational thinking and reflection.
CO3: To inculcate cognitive skills for better problem-solving.
CO4: To guide students towards practising mediation and conflict-resolution.

Unit-I: Communication and Barriers to Communication: 7C's of Communication, Win-Win Communication, Strategies for Effective Communication, Zero-Sum; Reasons for Conflict; Communication Barriers.

Unit-II: Critical Thinking and Cognitive Skills: reason; analysis, synthesis, divide and rule; root-cause analysis; logic and logical fallacies.
Reasoning; Logic; Inductive and Deductive Reasoning; Logical fallacies: *Ad hominem*, straw man fallacy; bandwagon fallacy; hasty generalization; false dilemma; false dichotomy; *Tu Quoque*; circular reasoning and hasty generalization; Recognizing fallacies.

Unit-III: Mediation and Conflict-Resolution: Cognitive Skills and Critical thinking; Listening for key words, phrases and hints, Creative Communicating, Managing and celebrating Diversity, Adaptability and Negotiation; Dispute-resolution; arbitration; mediator's role; caucuses, third party, objectivity, impartiality, neutrality, offers, counter offers, questions, demands, and proposals, impasse, settlement.Brainstorming, Problem solving strategies, Stress management, Significance of Collaboration, Confronting challenges.

Unit-IV: Mediation in Practice: Exercises in role-playing and mediation and one case study assignment as directed by the teacher.

Course Outcomes:

CO1: Students will demonstrate great interpersonal communication skills.
CO2: Students will adopt the habit of rational thinking and reflection.
CO3: Students will adopt cognitive skills for better problem-solving.
CO4: Students will practise communication for mediation and conflict-resolution.

Suggested Readings:

1. Kaul Asha, The Effective Presentation, Response Books, New Delhi.
2. Sanghi Seema, Towards Personal Excellence, Response Books, New Delhi.
3. Robbins Stephen and Sanghi Seema, Organizational Behaviour. Pearson. Latest Edition.
4. Bretag, Crossman and Bordia. Communication Skills. Tata Mc Graw-Hill.

Value Added Course (VAC)
B.Sc. (H) Physics
SEMESTER- II
CODE: VAC-103-N1
SUBJECT NAME: YOGA AND MEDITATION
NO OF CREDITS: 2

NO OF CREDITS: 2 **SESSIONAL: 25**

L	T	P	THEORY EXAM: 75
2	0	0	TOTAL: 100

Duration of Exam: 3 hrs.

Unit-I:
Introduction to yoga and its different levels, food habits, Sanskar of a yogi, Patanjali Yogsutra, its importance in life, benefits and history of yoga.

Unit-II:
Meditation and its relation with yoga, mind relaxation, development of morality and ethics, prayer and its meaning, its importance in life, benefits and history of meditation. Mantra and their importance, introduction to some chanting mantras, practicing some of mantrasGayatri Mantra, Namokar Jaap etc.

Unit-III:
Pranayam and its introduction, types of pranayam, breathing exercises, preliminary preparation before pranayam, its importance and benefits in life. Practice of different types of Pranayam: Anulom-Vilom, Kapalbhati, Nadi Shodhan, Agni Sar, Bhastrika, Bharamari etc.

Unit-IV:
Aasan and their types, benefits of different aasans, practicing of different aasans: Padamaasan, surya-namaskar, tadaasan, navaasan, gomukh aasan, bhujang aasan etc.

Reference Books:

1. PATANJALI YOGSUTRA – GITA PRESS GORAKHPUR
2. AASAN PRANYAM MUDRA BANDH – SATYANANDA SARASWATI
3. YOGA SADHNA -SWAMI RAMDEV

Minor Degree Course

in

Nano Science and Nano Technology

Scheme and Syllabus

ACADEMIC SESSION

(w.e.f. 2023-2024)

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.

Minor Degree Course

Nano Science and Nano Technology

Brief description:

Nano Science and Nano Technology: The Nano Science and Nano TechnologyMinor Degree Program offered by the Department of Physics provides a means for undergraduate students to familiarize themselves with the concepts and principles of Nano Science and Nano Technology. Nanotechnology is an exploding field where materials are created through the control of matter on the nanometer-length scale, at the level of atoms and molecules, and then combined into larger structures with profoundly different physical, optical, chemical, and mechanical properties. This capability is the result of many developments in the last two decades of the 20th century, including inventions of scientific instruments like the Scanning Tunneling Microscope, Atomic Force Microscope, etc. Using such tools, scientists and engineers have begun controlling the structure and properties of materials and systems at the scale of 10 -9 m, or 1/100,000 the width of a human hair. Scientists and engineers anticipate that nanoscale work will enable the development of materials and systems with dramatic new properties relevant to virtually every sector of the economy, such as medicine, telecommunications, and computers, and to areas of national interest.

Scheme:

Course Structure						
S. No.	**Course Code**	**Title**	**L**	**T**	**P**	**Credits**
1	MDN-101	INTRODUCTION TO NANOSCIENCE AND NANO TECHNOLOGY	4	-	-	4
2	MDN-102	NANO-MATERIALS SYNTHESIS	4	-	-	4
3*	MDN-103(A)	CHARACTERIZATION TOOLS OF NANOMATERIALS	4	-	-	4
	MDN-103(B)	GREEN NANO TECHNOLOGY		-	-	
4#	MOOC	Selected from Swayam Portal related to Nanotechnology	4			4
Total			16			16

*One paper may be selected by students

#MOOC: **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
Minor Degree	Sem. I to Sem. II

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.

General Information:

Eligibility/ Target Students	All Branches
Duration of program	One Year
Intake	Minimum 20 Students
Mode of Delivery (Class room / MOOC)	Both
Proposed Fee	Rs. 10,000/- (Rupees Ten Thousand) per year

Detailed Syllabus

Minor Degree Course

Nano Science and Nano Technology

Objectives of the course:

The objectives of Minor Degree in **Nano Science and Technology** course are

- To provide an intensive and in-depth learning to the students in field of **Nano Technology**.
- Beyond simulating, learning, understanding the techniques, the course also addresses the underlying recurring problems of disciplines in today scientific and changing business world.
- To develop awareness & knowledge of different organization requirement and subject knowledge through varied subjects and training methodology in students.
- To train the students to take up wide variety of roles like researchers, scientists, consultants,entrepreneurs, academicians, industry leaders and policy.

Course Code :	**MDN:101**
Course Title :	**INTRODUCTION TO NANOSCIENCE AND NANO TECHNOLOGY**
Number of Credits :	**Credit (L: 4 ; T:0 ; P:0 ;)**
Course Category :	**Minor Degree Course**
Offered by Department:	**Physics**

Course Objective:

The goal of this course is to provide an insight into the fundamentals of Nanoscience and nanotechnology. The course provides basics of nanomaterials, quantum mechanics and statistical mechanics

.

Module 1 : Background to Nanotechnology **(15)**

Basic principles of Nono science and NanoTechnology; Superconducting nano particles; Fragmentation of nanoparticles; Rare gas clusters;Molecular clusters; Methods of synthesis of Nano particles

Module 2: Nano Structure Materials **(15)**

Quantum wires and dots; Fabrication of Quantum Nano Strutures; Properties of Quantum Nano structures (a)Confinement of Conduction Electrons (b) Change in density of states(c) Single electron Tunneling.

Module 3: Carbon Nanostructures and Bulky Balls **(15)**

Carbon nano tubes; fabrication of nanotubes; structure of nanotubes; properties of nanotubes; (a) electrical properties (b) magnetic properties (c) vibrational properties (d) mechanical properties; Applications of Carbon Nono tubes:

Module 4: Applications of Nano Technology **(15)**

Nano- electro-mechanical systenst(NEMS); Actuators: Molecular Switches; Nano structures of Biomaterials; Biometrics and multilayer film; Metal Nanocluster composite glasses; Nano

Crystals; Ferrofluids. Applications of Quantum Structures (a) Infra red detecters (b) Quantum dot lasers (c) Superconductors

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

- Know the basic sciences required to understand the fundamentals of Nano Technology.
- Acquire the knowledge of Nano Structure Materials .
- Familiarize with the basic concepts of Carbon nano tubes and its properties
- Know application of nanotechnology

References:

1. M. Wilson, K. Kannangara, G Smith, M. Simmons, B. Raguse, Nanotechnology: Basic science and Emerging technologies, Overseas Press India Pvt Ltd, New Delhi, First Edition,2005.
2. C.N.R.Rao, A.Muller, A.K.Cheetham (Eds), The chemistry of nanomaterials: Synthesis, properties and applications, Wiley VCH Verlag Gmbh&Co, Weinheim, 2004.
3. Kenneth J. Klabunde (Eds), Nanoscale Materials Science, John Wiley & Sons, InC, 2001.
4. C.S.S.R.Kumar, J.Hormes, C.Leuschner, Nanofabrication towards biomedical applications,Wiley –VCH Verlag GmbH & Co, Weinheim, 2004.
5. W. Rainer, Nano Electronics and information Technology, Wiley, 2003.
6. K.E.Drexler, Nano systems, Wiley, 1992
7. G.Cao, Naostructures and Nanomaterials: Synthesis, properties and applications, ImpericalCollege Press, 2004.
8. Physics for Engineers Vol-II, B. S Rajput and M. P Singh, Pragati Prakashan. Meerut (UP)
9. Other relevant references may be added

Course Code :	**MDN:102**
Course Title :	**NANO MATERIALS SYNTHESIS**
Number of Credits :	**Credit (L: 4 ; T:0 ; P:0 ;)**
Course Category :	**Minor Degree Course**
Offered by Department:	**Physics**

Course Objective:

The intended course covers the whole spectrum of nanomaterials ranging from overview, synthesis, properties, and characterization of nanophase materials.

Module 1: Basics of Fabrication Methods **(15)**

Top-Down fabrication methods –Types of Top-Down fabrication methods (mechanosynthesis, thermal, high energy, chemical fabrication and lithography-concepts with examples only). Bottom-Up fabrication methods-Types of Bottom-Up fabrication methods (gaseous-phae, liquidphase, solid-phase, template synthesis-concepts with examples only). Nano perspective of the fabrication methods.

Module 2: Physical Methods **(15)**

Physcal Vapour Deposition (PVD), Inert gas condensation, Arc discharge, DC sputtering, Ion sputtering, RF & Magnetron sputtering ,Pulse Laser Deposition (PLD), Ball Milling, Molecular beam epitaxy, Electro-deposition

Module 3: Chemical Methods **(15)**

Metal nanocrystals by reduction, Sol- gel, Solvothermal synthesis, Photochemical synthesis, Electrochemical synthesis, Nanocrystals of semiconductors and other materials by arrested precipitation, Thermolysis routes, Liquid-liquid interface.

Module 4: Self assembly and Lithography **(15)**

Self assembly, Process of self assembly, colloids, Introduction to Lithography, E-beam Lithography, Ion Beam Lithography, Optical Lithography (Photolithography), X-ray Lithography.

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

1. Acquaint themselves with the excited subject though they are novice, whereas advanced learners will equip themselves to solve the complicated issues further.
2. Know about the importance of the synthesis method addressed in the material properties and give practical experience of nanomaterials synthesis/properties
3. Gather a sound understanding of the various concepts involved in fabrication of device architectures and able to evaluate them in advance

References:

1. Edelestein A.S and Cammarata RC, Nano materials synthesis, properties and applications:
2. Michael Kohler, Wolfgang Fritzsche, Michael Kohler, Wolfgang Fritzsche, Nanotechnology-An Introduction to Nano structuring Techniques Wiley (Practical)
3. Brian Robinson, Self-Assembly,IOS Press
4. Tai Ran – Hsu, MEMS and Microsystems, Design, Manufacture and NanoscaleEngineering, John Wiley & Sons, 2008.
5. M. Gentili, C. Giovannella, S. Selci, Nanolithography: A Borderland between STM, EB, IBand X-Ray Lithographies (NATO ASI Series), Kluwer Academic Publishers, 1994.
6. Nicholas A. Kotov, Nanoparticle Assemblies and Superstructures", CRC, (2006).
7. Guozhong Cao, Nanostructures & Nanomaterials Synthesis, Properties G; Z, Applications,World Scientific Publishing Pvy. Ltd., Singapore 2004
8. Zheng Cui, Nanofabrication, Principles, Capabilities and Limits, Springer Science + business media, New York (2008).
9. Kostya (Ken) Ostrik0ov and ShuyanXu, Plasma-Aided Nanofabrication: From Plasma Sources to Nanoassembly, WILEY-VCH Verlag GmbH & Co. KGaA (Weinheim) (2007)
10. Other references may be added.

Course Code :	**MDN:103(A)**
Course Title :	**CHARACTERIZATION TOOLS OF NANOMATERIALS**
Number of Credits :	**Credit (L: 4 ; T:0 ; P:0 ;)**
Course Category :	**Minor Degree Course**
Offered by Department:	**Physics**

Course Objective:
Nanomaterial characterization provides an introduction to different nanomaterial characterization techniques. Different characterization techniques are classified according to the concept/group of the technique used, the information they can provide, or the materials that they are destined for.

Module I: Structural characterization techniques **(15)**

X-ray diffraction (XRD) technique, particle size determination using XRD, Applications of XRD, Electron diffraction and its application, neutron diffraction and its applications

Module 2: Optical and Electron Microscopy **(15)**

Introduction to Optical microscopy, Scanning Electron Microscopy, Transmission Electron Microscopy, Scanning Tunneling Microscopy, Atomic Force Microscopy. Scanning probe microscopy e.g. Scanning Tunneling Microscopy (STM).

Module 3: Spectroscopic Techniques **(15)**

UV visible spectroscopy, Infrared Spectroscopy and Fourier Transform Infrared Spectroscopy, Raman Spectroscopy, Photoluminescence (PL), Photoelectron Spectroscopy (X-Ray Photoelectron Spectroscopy, Auger Electron Spectroscopy & Ultra Violet Photoelectron Spectroscopy)

Module 4: Characterization of Quantum structures **(15)**
Quantum structures Particle diameter by HRTEM Photoluminescent properties, Excitation wavelength, Photoluminescence by Micro plate Reader Photostability, Quantum yield.

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

- Have a thorough theoretical background and hands-on experience on a variety of experimental techniques that are used for the characterisation of bulk nanomaterials.
- describe techniques used for the evaluation of surface properties of materials
- explain the underlying principle of means of detection/signal generation for surface analysis techniques
- name and describe the underlying principles for the techniques used for structural characterization of materials

REFERENCES:

1. Zhong Lin Wang, Handbook of Nanophase and Nanomaterials (Vol I and II) Springer
2. C.R. Brundle, C.A. Evans Jr., and S. Wilson (eds), Encyclopedia of Materials Characterization, Butterworth Heinemann, Stoneham, Ma
3. J.C.Vickerman, Surface Analysis: The Principal Techniques, John Wiley and Sons
4. Roland Wiesendanger, Scanning Probe Microscopy and Spectroscopy: Methods and Applications, Cambridge Univ press
5. T. Pradeep, Nano: The essentials, understanding Nanoscience and Nanotechnology, TataMcGraw Hill, 2007.
6. Willard, "Instrumental Methods of Analysis", Van Nostrand, 2000
7. J. Goldstein, D. E. Newbury, D.C. Joy, and C.E. Lyman et.al, Scanning ElectronMicroscopy and X-ray Microanalysis, Springer Publications, 2003.
8. S.L. Flegler, J.W. Heckman and K.L. Klomparens, Scanning and Transmission ElectronMicroscopy: An Introduction, Oxford University Press, 1993.
9. P.J. Goodhew, J. Humphreys, R. Beanland, Electron Microscopy and Analysis, Taylor and Francis, 2001
10. R. Haynes, Optical Microscopy of Materials, International Textbook Co, 1984.
11. Zhong Lin Wang, Characterization OfNanophase Materials, Wiley-VCH, Verlag GmbH, Germany (2004).
12. W.R. Fahrner, Nanotechnology and Nanoelectronics Materials, Devices, Measurement Techniques, Springer-Verlag Berlin, Germany (2006).
13. Hans P.O., and Hopster H., —Magnetic Microscopy of Nanostructures", Springer (2004)
14. Vladimir G. Bordo and Horst-Günter Rubahn; Optics and Spectroscopy at Surfaces and Interfaces, John-Wiley and Sons, Inc., (2005).
15. William W. Parson, Modern Optical Spectroscopy, Springer, (2007).
16. Other relevant references may be added.

Course Code :	**MDN:103(B)**
Course Title :	**GREEN NANO TECHNOLOGY**
Number of Credits :	**Credit (L: 4 ; T:0 ; P:0 ;)**
Course Category :	**Minor Degree Course**
Offered by Department:	**Physics**

Course Objective: To motivate students to gain knowledge in the field of Green Synthesis of nano materials and their application in daily life for waste management.

Module 1 : GREENER NANOSYNTHESIS **(15)**

Greener Synthetic Methods for Functionalized Metal Nanoparticles, Greener Preparations of Semiconductor and Inorganic Oxide Nanoparticles, green synthesis of Metal nanoparticles, Nanoparticle characterization methods,

Module 2: NANOMATERIALS FOR "GREEN" SYSTEMS **(15)**

Green materials, including biomaterials, biopolymers, bioplastics, and composites Nanotech Materials for Truly Sustainable Construction: Windows, Skylights, and Lighting. Paints, Roofs, Walls, and Cooling.

Module 3: NANOMATERIALS FOR ALTERNATIVE ENERGY **(15)**

Nanomaterials for Fuel Cells and Hydrogen Generation and storage, Nanostrcutures for efficient solar hydrogen production, Metal Nanoclusters in Hydrogen Storage Applications, Metal Nanoparticles as Electrocatalysts in Fuel Cells, Nanowires as Hydrogen Sensors, Ceramic nanocomposites for alternate energy and environment protection.

Module 4: NANOMATERIALS IN ENERGY STORAGE DEVICES **(15)**

MWNT for Li Ion Batteries, Nanomaterials in Electrodes, Hybrid Nanotubes: Anode Material, Supercapacitor, Battery Electrodes Metal nanocluster catalysts for Coal Liquefaction. Nanomaterials for Desalination and Purification of Water.

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

- Make the students familiar with the field of traditional manufacturing to green manufacturing.
- Familiarize with various processing of sustainable green synthesis.
- Familiarize with different types of waste management.
- Develop the knowledge about the basic concepts of Energy Storage.

REFERENCES

1. David. T, Allen and David R. Shonnard, —Green engineeringl Prentice Hall NJ, 2002.
2. David Dornfeld, —Green manufacturing fundamental and application" Prentice hall, 2002.
3. Sammy Shinga. G —Green electronics design and manufacturing"Prince publications, 2008.
4. James clark, —Green chemistry" Blackwell publishing, 2008.
5. Paulo Davim, —Sustainable Manufacturing" Wiley publications, 2010.
6. Frank Kreith, George Tchobanoglous, —Solid waste management" McGraw Hill, 2002.
7. Stevens. E. S —Green plastics" Princeton university press, 2002.
8. Robert Ayres. U —A Handbook of Industrial Ecology" Edward elgar publishing, 2002
9. Other relevant references may be added.

Advantages of the Course:

Nanotechnology has tremendous job potential including

- Trading,
- industrial job
- Entrepreneurship
- Consultancy organizations in pharmaceuticals, Electronics, Energy, Material Science,Medical, Defense, Agriculture, Environment Protection etc.
- Job in Scientific Research Organizations.
- Universities in India & abroad.
- Hospitals and healthcare

Minor Degree Course

in

Renewable Energy

Scheme and Syllabus

ACADEMIC SESSION

(w.e.f. 2023-2024)

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.

Minor Degree Course

in

Renewable energy

Brief description:

The Minor Degree program in Renewable Energy will equip students with the knowledge, skills, and experience necessary to address the complex environmental challenges of the 21st Century. This program is intended to build students into leaders in a wide range of careers in conservation, consulting, energy, natural resources, planning, policy, sustainability, and more. This program is specially designed for those interested in energy policy or wanting a career in the energy sector, including in both renewable and conventional energy. The Renewable Energy program will provide a pragmatic, rigorous, and interdisciplinary understanding of energy from three perspectives: science and technology, policy, and business.

Scheme:

Course Structure						
S. No.	**Course Code**	**Title**	**L**		**T P**	**Credits**
1	MDRE-101	INTRODUCTION TO RENEWABLE ENERGY	4	-	-	4
2	MDRE-102	ENERGY STORAGE SYSTEM	4	-	-	4
3	MDRE-103	ENERGY STORAGE MATERIALS & CHARACTERIZATIONS	4	-	-	4
4#	MOOC		4			4
Total			16			16

MOOC: **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
Minor Degree	Sem. III to Sem. VI

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

4. A student has to register for the course for which he is interested and eligible which is approved by the department with the help of 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.

General Information:

Eligibility/ Target Students	All Branches
Duration of program	Two Years
Intake	Minimum 20 Students
Mode of Delivery (Class room / MOOC)	Both
Proposed Fee	Rs. 10,000/- (Rupees Ten Thousand) per year

Detailed Syllabus

of

Minor Degree Course

in

Renewable Energy

Course Code :	**MDRE:101**
Course Title :	**INTRODUCTION TO RENEWABLE ENERGY**
Number of Credits :	**Credit (L: 4 ; T:0 ; P:0 ;)**
Course Category :	**Minor Degree Course**
Offered by Department:	**Physics**

Course Objectives

- Understanding basic characteristics of renewable sources of energy and technologies for their utilization for the thermal and electrical energy needs and also the environmental aspects of these resources
- To equip students in working with projects and to take up research work integrating with renewable power sources.
- To provide un-energized and off-grid areas through affordable and reliable source of energy

.Learning Outcomes

- Understand the role of renewable energy in product and service sectors, as well as its importance in the energy chain: processing, transportation, distribution and end use.
- To understand role significance of solar energy, wind energy, biomass and other renewable energy sources and technologies for their utilization.
- To get the utilization of Biogas plants and understand the concept of energy Conservation

Course Syllabus

Module 1: Introduction

Classification of Energy Resources; Conventional Energy Resources - Availability and their limitations; Non-Conventional Energy Resources – Classification, Advantages, Limitations; Comparison of Conventional and Non-Conventional Energy Resources; World Energy Scenario; Indian Energy Scenario. Energy Storage: Sizing and Necessity of Energy Storage.

Module 2: Solar Energy (Thermal and Optical)

Principle of Conversion of Solar Radiation into Heat, – Solar thermal collectors – General description and characteristics – Flat plate collectors – Heat transfer processes – Solar

concentrators (parabolic trough, parabolic dish, Central Tower Collector) –performance evaluation, solar cooker, solar dryer, solar pond and solar distillation

Solar Thermal Electric Power Generation –; Solar Photovoltaic – Solar Cell fundamentals, characteristics, classification, construction of module, panel and array. Solar PV Systems – stand-alone and grid connected; Applications – Street lighting, Domestic lighting and Solar Water pumping systems.

Module 3: Wind and Biomass Energy

Introduction, Wind and its Properties, Wind Energy Estimation, Types of Wind Energy Systems, Performance, Site Selection, Details of Wind Turbine Generator. Basic principles of Wind Energy Conversion Systems (WECS), Classification of WECS, Parts of WECS, Derivation for Power in the wind, Electrical Power Output and Capacity Factor of WECS, Advantages and Disadvantages of WECS.

Introduction, Principles of Bio-Conversion, Anaerobic/aerobic digestion, types of Bio-gas digesters, gas yield, combustion characteristics of bio-gas, Biomass fuels, Biomass conversion technologies, waste to Energy Conversion, Power generation from urban, municipal and industrial waste. Biomass Gasification, Biomass to Ethanol Production, Biogas production from waste biomass, factors affecting biogas generation, types of biogas plants – KVIC and Janata model; Biomass program in India.

Module 4: Other Sustainable Energy Resources

Kinetic and potential energies of fast flowing rivers (particularly in hilly regions), River flow energy, Conversion of River flow energy into Shaft energy, Power generation by fast flow of rivers, Energy generation from flooded rivers; Geothermal energy, Hot water springs, Principles of Geo- thermocouple, Array of Thermocouples for power production, Tidal Energy, conversion of tidal energy into Shaft energy (in regions near oceans)

References:

1. Reneweble energy resources: Tiwari and ghosal, Narosa publication.
2. Non conventional Energy Sources,Khanna Publication.
3. Renewable Energy Sources:Twidell& Weir, CRC Press.
4. Solar Energy/ S.P. Sukhatme, Tata McGraw-Hill.
5. Non Conventional Energy Systems: K M. Mittal, A H WheelerPublishing Co Ltd.
6. Renewable Energy Technologies: Ramesh & Kumar, Narosa publication.
7. Biomass Energy, Oxford &IBH Publication Co.

Course Code :	**MDRE:102**
Course Title :	**ENERGY STORAGE SYSTEM**
Number of Credits :	**Credit (L: 4 ; T:0 ; P:0 ;)**
Course Category :	**Minor Degree Course**
Offered by Department:	**Physics**

Course Objectives

- To provide a foundation for understanding the general principles and fundamentals of Li-Ion battery technology design and operation.
- To understand the expectancy of the hydrogen as a fuel and energy vector in the context of the renewable energy without CO_2.
- To learn basic electrochemical principles of the hydrogen fuel cells, basic fuel cell design concepts, fuel cell systems concepts.

Learning Outcomes

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

- State the various parts of the battery and their functions.
- Describe discharging and charging process of a lithium ion battery.
- Describe the components of a fuel cell and explain the purpose of each one. · Explain and analyse dynamic fuel cell behaviour.
- Understand - how fuel cells are used for every day purposes: road, water and air transport vehicles, portable and stationary use.

Course Syllabus

Module 1: Battery technology Overview

Battery definitions, terms and terminology, Battery types and their properties, Introduction to lithium ion battery, Components, functions, advantages and disadvantages of lithium-ion batteries, Growth & development of Li-Ion batteries, charging procedures, Safety of lithium ion batteries, Lifetime.

Module 2: Classification of Batteries

Types of lithium ion battery: Lithium Cobalt Oxide (LCO), Lithium Iron Phosphate Battery (LFP), Lithium Manganese Oxide (LMO), Lithium Nickel Cobalt Aluminium Oxide (LNCA), Lithium Nickel Manganese Cobalt Oxide (LNMC), Lithium Polymer Battery, Lithium Polymer Battery technology, Difference between the lithium ion and lithium polymer.

Module 3: Fuel Cells

Introduction to fuel cells, components of fuel cells, Types of fuel cells: Alkaline fuel cells, proton exchange membrane fuel cell, phosphoric acid fuel cell, molten carbonate fuel cell.

Solid oxide fuel cell, Types of solid oxide fuel cells: High temperature, intermediate temperature Single chamber solid oxide fuel cells, Problems with fuel cells.

Working Principle and Application of fuel cells: working principle of fuel cell, performance characteristics of fuel cells, efficiency of fuel cell, fuel cell stack, description of some commercially available fuel cell stacks, fuel cell cars and buses, overview on research activities.

Module 4: Micro Energy Sytems

Microhydle systems: lifting water of fast flowing river by suitably designed turbines (using only the kinetic energy of river flow), Storing the lifted water on the tops of nearby hill peaks, power production on chanellizing the stored water, Microhydle generators, Array of Micro hydel generators.

Geothermal Energy Production: Principle of Thermocouples, Thermocouple between boiling hot water emerging from natural hot water spring and the ice cold water of neighbouring river, Array of suitably designed thermocouples, Geothermal power generation

Tidal power generation: Continuous conversion of tidal energy into Shaft energy, Design of suitable turbines and motors using tidal energy, Conversion of tidal energy into electrical energy.

References:

1. Lithium-Ion Batteries Basics and Applications by Reiner Korthauer, Springer.
2. Lithium-Ion Batteries Science and Technologies by Ralph J. Brodd (auth.), Masaki Yoshio, Ralph J. Brodd, Akiya Kozawa (eds.), Springer.
3. Lithium-ion Batteries Fundamentals and Applications. by Wu, Yuping, CRC Press, Taylor and Francis.
4. O'hayre, S.W. Cha, W.G. Colella, F.B. Prinz, Fuel Cell Fundamentals, 3rd edition, Wiley publisher.
5. High-temperature Solid Oxide Fuel Cells for the 21st Century, Second Edition Fundamentals, Design and Applications by Kendall, Kevin Kendall, Michaela.
6. Fuel cells from fundamentals to applications by Supramaniam Srinivasan, Springer.
7. Handbook of lithium-ion battery pack design chemistry, components, types and terminology by Warner, John T, Elsevier.
8. Fundamentals and Application of Lithium-ion Battery Management in Electric Drive Vehicles by San Ping Jiang, Wiley.
9. Lithium ion rechargeable batteries by edited by Kazunori Ozawa, Wiley.
10. E. Lipman, A. Z. Weber, Fuel Cells and Hydrogen Production, A Volume in the Encyclopedia of Sustainability Science and Technology, Second Edition, Springer reference.
11. Modern electric, hybrid electric, and fuel cell vehicles fundamentals, theory, and design by Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay, Ali Emadi, CRC press

Course Code :	**MDRE:103**
Course Title :	**ENERGY STORAGE MATERIALS & CHARACTERIZATIONS**
Number of Credits :	**Credit (L: 4 ; T:0 ; P:0 ;)**
Course Category :	**Minor Degree Course**
Offered by Department:	**Physics**

Course Objectives

This course will educate the students the concepts and operation of accessible energy storage systems, significance of energy storage in current scenario, reason and transfer of efficiency losses in different energy storage systems.

This course is designed to help the students to provide adequate knowledge regarding nanomaterials in fuel cells, hydrogen Storage, thermoelectric materials (in nano scale), supercapacitors.

The students will also learn various types of batteries used in modern technology and the intercalation of nanomaterials inside them.

Learning Outcomes

- The students will be able to know the usage of nano-materials in various battery applications (Li ion battery, K ion battery, Na ion battery)
- The students will be able to know the utilization of next generation super-capacitors and its applications.
- The students will be able to understand the use of nanomaterials in fuel cells, various hydrogen storage systems, and thermoelectric materials.

Course Syllabus

Module 1: Electrochemical Characterizations

Electrochemical Characterizations: Linear Sweep Voltammetry, Cyclic Voltammetry, Galvanostatic Charge Discharge, Electrochemical Impedance Spectroscopy, Three electrode set up, Two electrode set up, specific capacitance, specific capacity, energy density, power density, ragone plot.

Module 2: Energy Materials

Nanotechnology in energy research, Fossil fuels, Nanotechnology in fuel production, Renewable energy sources; Advantages of renewable energy sources, Metal oxides framework (MOF), Mxenes

Thermoelectric materials (bulk), Thermoelectric materials (in nanoscale), Thermoelectric

nanocomposites, Applications of thermoelectric nano materials

Module 3: Supercapacitors and hydroelectric cell

Supercapacitors, Types of supercapacitors, Design of supercapacitors, Carbon based materials for supercapacitors, Necessary parameters for supercapacitors, Applications, Introduction of hydroelectric cell with applications.

Module 4: Energy harvesting/storage

Semiconductor based Hydrogen production; Selection of nanomaterials for energy harvesting and storage applications; Other significant materials for Hydrogen storage; Thermal energy storage systems

References:

1. Robert A. Huggins; Energy Storage, Fundamentals, Materials and Applications
2. Kunihito Koumoto , Takao Mori ; Thermoelectric Nanomaterials
3. Electrochemical Supercapacitors for Energy storage and delivery; Aiping Yu, Victor Chabot, and Jiujun Zhang
4. Electrochemical Methods: Fundamentals and Applications; Allen J. Bard

Minor Degree Course

in

Radiation Physics

Scheme and Syllabus

ACADEMIC SESSION

(w.e.f. 2023-2024)

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.

Minor Degree Course

Radiation Physics

Brief description:

Radiation Physics: The Radiation Physics Minor Degree Program offered by the Department of Physics targets to acquaint the students with basic knowledge and preliminary skills of radiation physics. Different types of radiations are explored and being extensively used in wide range of fields, spanning from medical, environmental to energy harvesting. In medical applications, the radiology is important in the detection and treatment of various diseases including cancer. The basics of radiations are also important to understand the interactions between radiation and matter. This helps in characterization of materials via identification, analyzing their properties and tailoring their behavior for the desired applications. The physics of radiations like electromagnetic radiations are also useful for energy harvesting. The understanding of nuclear radiation provides opportunities to contribute in the areas of atomic energy, radiotherapy and nuclear waste management. The minor degree course aims to bridge the basic understanding with the modern tools for imaging, medical treatments, energy and environment.

Scheme:

Course Structure						
S. No.	Course Code	Title	L	T	P	Credits
1	MDRP-101	BASICS OF RADIATION PHYSICS	4	-	-	4
2	MDRP-102	RADIATION DETECTION AND MEASUREMENT	4	-	-	4
3*	MDRP-103(A)	SPECTROSCOPIC TECHNIQUES AND RADIATION DOSIMETRY	4	-	-	4
	MDN-103(B)	NUCLEAR RADIATION SAFETY AND WASTE MANAGEMENT		-	-	
4#	MOOC		4			4
Total			16			16

*One paper may be selected by students

#MOOC: **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
Minor Degree	Sem. I to Sem. II

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.

General Information:

Eligibility/ Target Students	All Branches
Duration of program	One Year
Intake	Minimum 20 Students
Mode of Delivery (Class room / MOOC)	Both
Proposed Fee	Rs. 10,000/- (Rupees Ten Thousand) per year

Detailed Syllabus

Minor Degree Course

Basics of Radiation Physics

Objectives of the course:

The objectives of Minor Degree in **Radiation Physics** course are

- Impart knowledge of various types of radiation, their properties and quantification.
- Demonstrate an understanding of basic scientific principles, theories, and laws of radiation physics.
- Develop the critical thinking and approach using the basic concepts of radiation physics for various applications.
- Capable of making efficient use of library and other information sources in assessing radiation physics problems.
- Inculcate knowledge for entrepreneurship in various nuclear radiation based equipments for medical and nuclear safety purposes.
- Explore the nuclear safety rules, regulations, measures, protection strategies and waste management methods.

Course Code :	**MDRP:101**
Course Title :	**BASICS OF RADIATION PHYSICS**
Number of Credits :	**Credit (L: 4 ; T:0 ; P:0 ;)**
Course Category :	**Minor Degree Course**
Offered by Department:	**Physics**

Course Objective:

The goal of this course is to provide an insight into the fundamentals of Radiation Physics. The course provides basics of quantum mechanics, atomic & nuclear physics and radiation physics.

Module 1: Special Theory of Relativity **(10)**

Michelson Morley Experiment and interpretation of it's negative results, Postulates of Special Theory of Relativity, Lorentz Transformation, Length Contraction, Time Dilation, Apparent Retardation of Clocks, Relativity of Simultaneity, Addition of Velocities, Variation of Mass with Velocity, Mass-Energy Equivalence, Energy- Momentum Relation.

Module 2: Dual Nature of Radiation and Matter **(20)**

Electromagnetic nature of Radiation, Energy in Electromagnetic field (Poynting Theorem), Transverse nature of EM wave in free space, Electromagnetic Spectrum, Photo-electric effect; Compton effect, Dual nature of Radiation, de Broglie's Matter wave, Phase and group velocities of Matter wave, Dual Nature of Matter, Heisenberg's uncertainty relation, Bohr's Complementarity Principle, Schrodinger's wave equation, Wave function and wave packet, Postulates of Quantum Mechanics, Formalism of Quantum Mechanics, Eigen values and Eigen vectors of Quantum Operators, Quantum Dynamics, Dimensionality of Quantum space, Solution of one- dimensional Schrodinger equation (harmonic oscillator), Ehernfest Theorem., Solution of Schrodinger equation for Coulomb potential (Hydrogen atom problem).

Module 3: Elementary Idea of Radiations **(15)**

Rutherford's Nuclear Model of Atom, Bohr's Model, Bohr Model of Hydrogen Atom, Line Spectra of Hydrogen and Hydrogen-like Atoms, Atomic Masses and Composition of Nucleus, Discovery of Neutron, Size of the Nucleus, Mass-Energy and Nuclear Binding Energy, Radioactivity, Basic parameters of radioactivity (Decay law, Decay constant, Activity, Half-life, Average life time). Types of decay: Alpha decay (Properties, charge to mass ratio, range, Gamow's Theory of Alpha-Decay), Beta decay (Types, energetics), and Gamma decay (Energetics of Gamma decay).

Module 4: Interaction of Radiations with Matter **(15)**

Absorption, Reflection and Transmission of EM radiations, Interaction of light charged Particles, Interaction of heavy charged Particles (Bohr's formula for Stopping power of heavy charged particles, Bethe-Block Formula, 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, Nuclear Reactions, Mass Defect, Nuclear Fission and Fusion.

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

- Understand the basics of atomic, nuclear and quantum physics required for applications of radiation physics.
- Develop the concepts related to various types of radiations and their properties.
- Analyze the interaction of radiations with matter.
- Build the critical thinking and approach for bridging the fundamentals to various applications.

References:

1. Physics for Engineers (Vol-I) by B. S. Rajput and M. P Singh (Pragati Prakashan).
2. Physics for Engineers (Vol-II) by B. S. Rajput and M. P Singh (Pragati Prakashan).
3. Modern Physics by R. Murugeshan (S. Chand and Comp.).
4. Techniques for Nuclear and Particle Physics Experiments by W R Leo (Springer-Verlag).
5. University Physics by Hugh D. Young, Roger A. Freedman, Lewis Ford (Pearson publishers).
6. Foundation of Quantum Mechanics by S. Wieder (Academic Press).
7. Quantum Mechanics by E. Merzbaker (Wisley).
8. Modern Quantum Mechanics by J. J. Sakurai (Pearson publishers).
9. Principles of Quantum Mechanics by P. Dirac (Oxford University Press).
10. Concept of Modern Physics by Arthur Beiser (McGraw-Hill Book Company).
11. Atomic spectra & atomic structure, Gerhard Hertzberg (Dover publication).
12. Nuclear Physics: Principle and Application by John Lilley (Wiley Pub.).
13. Concepts of Nuclear Physics by Bernard L. Cohen (TMH).
14. Nuclear Physics by S. N. Ghoshal (S. Chand Pub.).

Course Code :	MDRP:102
Course Title :	RADIATION DETECTION AND MEASUREMENT
Number of Credits :	Credit (L: 4 ; T:0 ; P:0 ;)
Course Category :	Minor Degree Course
Offered by Department:	Physics

Course Objective:
The intended course covers the detection methods and instrumentation of radiations.

Module 1: Basics of Detection **(15)**

Importance of Detecting Radiation, Basic concepts of cross section: Total cross section, Partial cross section, Differential cross section, Measurement of voltage, current, charge and frequency, Timing measurements, Leading edge and constant fraction discriminators, Coincidence measurements, Time to amplitude converter, Single and multi channel analyzers, Data acquisition system, Significant Digits, Variance & Co-variance, Correlation & Standard Errors, Sources of Errors, Statistics of counting: Normal, Poisson and Gaussian distribution.

Module 2: Gas Detectors **(15)**

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 (Working, The Geiger discharge, Geiger plateau, Counting efficiency).

Module 3: Solid State Detectors **(15)**

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

Module 4: Scintillation Detectors **(15)**

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), Photo and electron multipliers: Photomultiplier tubes and Channel electron multipliers.

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

1. Learn about the theoretical aspects of design and usage of various nuclear detectors and their applications in the field of nuclear physics.
2. Understand various operation regions in different gas filled, solid state and scintillator detectors.
3. Review merits and de-merits of detection for each detector.

References:

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).

Course Code :	MDRP:103(A)
Course Title :	SPECTROSCOPIC TECHNIQUES AND RADIATION DOSIMETRY
Number of Credits :	Credit (L: 4 ; T:0 ; P:0 ;)
Course Category :	Minor Degree Course
Offered by Department:	Physics

Course Objective:
Nuclear Techniques and Radiation Dosimetry provides an introduction to various techniques available for characterization of materials and biological defects imaging. The course also provides an overview of radiation based therapy methods and their quantification.

Module 1: Elementary Idea of Spectroscopic Techniques **(15)**

Introduction, Electromagnetic radiation, Regions of spectrum, Basic features of spectroscopy, Atomic absorption spectroscopy (AAS), Atomic Emission Spectroscopy (AES), Atomic Fluorescence spectroscopy (AFS), UV/Visible spectroscopy, Fourier Transform Infrared spectroscopy (FTIR), Raman spectroscopy, Nuclear magnetic resonance (NMR) and Electron spin resonance (ESR) spectroscopy.

Module 2: Imaging Techniques for Medical Applications **(15)**

Projection imaging, imaging with external radiation and internal radiation, Computerized tomography, Positron emission tomography, Magnetic resonance imaging, Radiation therapy — using photons and electrons, radionuclides, neutrons and heavy charged particles.

Module 3: Biological effects of radiation **(15)**
Direct and indirect physical damage, Indirect chemical damage, Dose, Dose rate and dose distributions, Dose limits, Regulatory requirement, Damage to critical tissues — complex molecules, nucleic acids and damage repair. Human exposure to radiation, Radiation in environment, Evaluation of dose — external radioactive source and inhaled and ingested radioactivity, Risk assessment, Risk to occupationally exposed workers, Radiation protection and measurement.

Module 4: Physics of Diagnostic and Therapeutic Systems **(15)**
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.

Course Outcomes: After a successful completion of the course, students would be able to
- Understand classification of characterization techniques and determination of crystal structure of specimen.
- Learn various imaging techniques used for medical applications.
- Analyze the risk factors and does limits of radiation therapy.

- Explore the physics of various diagnostic systems and their effect on the human body.

REFERENCES:

1. Introduction to Infrared and Raman spectroscopy by Norman D Colthup, Lawrence H Daly and Stephen E Wiberley (Academic press).
2. Instrumental methods of analysis by H.H. Willard, L.L. Merrit, J.A. Dean & F.A. Settle (CBS Pub.).
3. Introduction to Radiological Physics and Radiation Dosimetry by Frank H. Attix (John Wiley & Sons).
4. Physics of Radiation Therapy by F M Khan (Williams and Wilkins).
5. Basic Radiological Physics by Dr. K.Thayalan (Jayapee Brothers Medical Publishing Pvt. Ltd. New Delhi).
6. The essential physics of Medical Imaging by Bushberg, Seibert, Leidholdt and Boone Lippincot (Williams and Wilkins).
7. Handbook of Physics in Diagnostic Imaging by R.S.Livingstone (B.I. Publication Pvt Ltd.).

Course Code :	**MDRP:103(B)**
Course Title :	**NUCLEAR RADIATION SAFETY AND WASTE MANAGEMENT**
Number of Credits :	**Credit (L: 4 ; T:0 ; P:0 ;)**
Course Category :	**Minor Degree Course**
Offered by Department:	**Physics**

Course Objective: To enrich students with the knowledge of radiation safety measures and protection. The students will also learn about the different methods of nuclear waste management.

Module 1: Nuclear Fuel Cycle **(15)**

In-depth technical and policy analysis of various options for the nuclear fuel cycle, Topics include uranium supply, enrichment fuel fabrication, in-core physics and fuel management of uranium, thorium and other fuel types, Reprocessing and waste disposal, Principles of fuel cycle economics and the applied reactor physics of both contemporary and proposed thermal and fast reactors are presented, Control and transient problems, Release of radioactivity from reactors.

Module 2: Nuclear Radiation Safety **(15)**

Integration of reactor physics and engineering sciences into nuclear power plant design, Topics include materials issues in plant design and operations, Aspects of thermal design, Fuel depletion and fission-product poisoning, and temperature effects on reactivity, Safety considerations in regulations and operations, The evolution of the regulatory process, Mitigation Measures of Nuclear/Radiological Emergencies, The concept of defense in depth, General Design Criteria, Probabilistic risk assessment, Risk informed regulations.

Module 3: Nuclear Disaster Management **(15)**

Nuclear and Radiological Emergency/Disaster Scenarios, 'Criticality' Accidents, Need for a Comprehensive National Radiation Emergency Management System, Paradigm Shift in Disaster Management in India, Nuclear Emergency Management Framework, Nuclear Emergency Preparedness, Capacity Development, Regulatory Body, Monitoring and Protective Equipment, Accident analysis.

Module 4: Nuclear Waste Management **(15)**

Introduces scientific and engineering aspects of the management of spent fuel, reprocessed high-level waste, Low-level wastes, and decommissioning wastes, Characteristics and classification of nuclear wastes and waste forms, Fundamental processes and governing equations of radionuclide transport in the environment, Discussion of performance assessment for repositories, Design principles and evaluation methods for geologic waste disposal systems.

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

- Make the students familiar with the nuclear fuel cycle.
- Familiarize with nuclear safety measures and their protection.
- Know various criterions for safety measures.
- Explore nuclear waste management rule, regulations and methods.

REFERENCES

1. Nuclear Fuel Management by H. W. Graves (John Wiley and Sons).
2. Nuclear Criticality Safety: Theory and Practices by Ronald A. Knief (American Nuclear Society).
3. Radiation Biophysics by Edward L. Alpen (Academic Press).
4. National Disaster Management Guidelines, National Disaster Management Authority, Government of India.

Advantages of the Course:

Radiation Physics has tremendous job potential including

- Trading,
- industrial job
- Entrepreneurship
- Consultancy organizations in pharmaceuticals, Electronics, Energy, Material Science, Medical, Defense, Agriculture, Environment Protection etc.
- Job in Scientific Research Organizations.
- Universities in India & abroad.
- Hospitals and healthcare