Learning Outcomes-Based Curriculum Framework

PHYSICS (Hons.)

(Effective from Academic Session 2021-22 onwards)

Rajiv Gandhi University, Doimukh-791112

Arunachal Pradesh, INDIA

APRIL 2021

05/7/2021

संयुक्त कुलसचिव (शैक्षणिक एवं सम्मेलन)
राजीव गांधी विश्वविद्यालय
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CONTENT

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INTRODUCTION & BACKGROUND

The learning outcome-based curriculum framework (LOCF) for a degree in B.Sc. Physics is intended to provide a broad framework, and helping the students to develop the required skill ability and for a successful continuation of their studies and research in field of Physics. The curriculum framework is designed and formulated in order to acquire and maintain standards of achievement in terms of knowledge, understanding and skills in Physics and their applications to the natural phenomenon. This will help the students to develop scientific orientation enquiring sprit, problem solving skills and values which foster rational and critical thinking. Due to an alone Central University of Arunachal Pradesh, Rajiv Gandhi University has been registering vast majority of students every year from this state as well as other parts of north east India. As per suggestion of UGC, a curriculum with high standard and learning outcome has been set by Board of Undergraduate Studies of Physics to respond diverse need of students and to provide flexibility to the teachers. The learning outcome-based curriculum framework in Undergraduate courses of Physics(H) allows for more flexibility and innovation in the program design to adopt latest teaching and assessment methods and include new areas of knowledge in the first evolving subject domains. The process of learning is defined by the following steps which form the basis of final assessment of the achievement at the end of the program.

- Development of an understanding and knowledge of basic Physics. This involves due exposure to basic facts of nature discovered by physics through observation and experiments. The other core components of these development are to introduce physics concept, principle and their theoretical relationships in laws of Physics and their in-depth understanding via appropriate problems.
- The ability of using the knowledge to analyze new physical problems and develop skills with tools like advanced mathematics, computational methods, laboratory techniques to find the appropriate solution, interpret the results and a meaningful prediction for the future development of Physics.
- The ability to synthesize the acquired knowledge, understanding and experience for a better and improved comprehension of the physical problems in nature and to create new skills and tools to face complexity.

LOCF FOR PROGRAM IN B.SC. (HONS.) PHYSICS

The UG programs in Physics builds on the basic Physics taught at the +2 level in all the schools in the country. Ideally, the +2 senior secondary school education should aim and achieve a sound grounding in understanding the basic Physics with sufficient content of topics from modern Physics and

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contemporary areas of exciting developments in physical sciences. The curricula and syllabi should be framed and implemented in such a way that the basic connection between theory and experiment and its importance in understanding Physics should be apparent to the student. This is very critical in developing a scientific temperament and urge to innovate, create and discover in Physics. Unfortunately, the condition of our school system in most parts of the country lacks the facilities to achieve the above goal, and it is incumbent upon the college/university system. The B.Sc. Physics courses are planned in such a way that it can fill up such gap of young minds and strengthen the understanding in a systematic way.

AIMS OF UG PROGRAM IN B.Sc.(HONS.) PHYSICS

The LOCF based UG educational program in Physics (Hons.) aims to

- create the facilities and environment in all the educational institutions to consolidate the knowledge acquired at +2 level and to motivate and inspire the students to create deep interest in Physics, to develop broad and balanced knowledge and understanding of physical concepts, principles and theories of Physics.
- provide opportunities to students to learn, design and perform experiments in the labs, gain an understanding of laboratory methods, analysis of observational data and report writing, and acquire a deeper understanding of concepts, principles and theories learned in the classroom through laboratory demonstration, computational methods and modelling.
- To develop an understanding of core physics at each stage a base knowledge about the behaviour of matter and radiation would expose the student to the vast scope in Physics
- Develop the ability to apply the knowledge and skills acquired through the classroom and laboratories for the solution of specific theoretical and experimental problems.
- To prepare student for pursuing the interdisciplinary and multidisciplinary research in Physics. The students are exposed to make recent potential branches of science necessary for interdisciplinary and multidisciplinary research.
- To emphasize the importance of Physics as one of the most important discipline for sustaining the existing industries and establishing new ones to create job opportunities and employment.

GRADUATE ATTRIBUTES FOR B.SC. PHYSICS (HONS.)

Some of the characteristic attributes of a graduate in Physics are

- **Disciplinary knowledge**
  (i) Comprehensive knowledge and understanding of major concepts, theoretical principles and experimental findings in core areas of Physics -like Classical Mechanics, Quantum mechanics, Thermodynamics, Statistical mechanics, Electricity, Magnetism,

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Electromagnetic theory, Wave Theory, Optics, Solid State Physics, and Analogue and Digital electronics; and in the chosen disciplinary elective sub-fields of the subject like Nuclear and Particle Physics, Analytical dynamics, Astronomy and Astrophysics, Advanced Mathematical Physics, Nanophysics and interdisciplinary subfields like Biophysics, Atmospheric Physics, etc.

(ii) Ability to use physics laboratory methods and modern instrumentation for designing and implementing new experiments in physics, interdisciplinary/multidisciplinary research areas and industrial research.

- **Skilled communicator:** Ability to transmit abstract concepts and complex information relating to all areas in Physics in a clear and concise manner through scientific report writing. Ability to express complex relationships and information through graphical methods and proper tabulation. Ability to explain complex processes through simulation and modelling. Ability to express complex and technical concepts orally in a simple, precise and straightforward language for better understanding.
- **Critical thinking:** Ability to distinguish between relevant and irrelevant facts and information, discriminate between objective and biased information, apply logic to arrive at definitive conclusions, find out if conclusions are based upon sufficient evidence, derive correct quantitative results, make rational evaluations, and arrive at qualitative judgments according to established rules.
- **Sense of inquiry:** Capability for asking relevant/appropriate questions relating to the issues and problems in the field of Physics and beyond. Planning, executing and reporting the results of theoretical or experimental investigation. Team player/worker: Capable of working effectively in diverse teams in both classroom, laboratory, Physics workshop and in field-based situation.
- **Skilled project manager:** Capable of identifying/mobilizing appropriate resources required for a project, and managing a project through to completion, while observing responsible and ethical scientific conduct, safety and laboratory hygiene regulations and practices.
- **Digitally Efficient:** Capable of using computers for computational and simulation studies in Physics. Proficiency in appropriate software for numerical and statistical analysis of data, accessing and using modern e-library search tools, ability to locate, retrieve, and evaluate Physics information from renowned physics archives, proficiency in accessing observational and experimental data made available by renowned research labs for further analysis.
- **Ethical awareness/analytical reasoning:** The graduates should be capable of demonstrating the ability to think and analyze rationally with modern and scientific outlook and adopt unbiased objectives and truthful actions in all aspects of work. They should be capable of identifying ethical issues related to their work. They should be ready to appropriately acknowledge direct and indirect contributions received from all sources, including from other personnel in the field of their work. They should be willing to contribute to the free development of knowledge in all forms. Further, unethical behaviour such as fabrication, falsification or misrepresentation of

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data, or committing plagiarism, or not adhering to intellectual property rights should be avoided.

- **Social, National and International perspective:** The graduates should be able to develop a perspective about the significance of their knowledge and skills for social well-being and a sense of responsibility towards human society and the planet. They should have a national as well as an international perspective about their work and career in the chosen field of academic and research activities.
- **Lifelong learners:** Capable of self-paced and self-directed learning aimed at personal development and for improving knowledge/skill development and reskilling in all areas of Physics.

QUALIFICATION DESCRIPTOR FOR B.SC. PHYSICS (HONS.)

The qualification descriptor for B.Sc. (Hons) Physics Graduates include the following:

They should be able to

- Demonstrate
  - (i) a systematic and coherent understanding of basic Physics including the concepts, theories and relevant experimental techniques in the domains of Mechanics, Electricity and Magnetism, Waves and Optics, Thermal Physics, Quantum Mechanics, Statistical Mechanics, Mathematical Physics and their applications in other areas of Physics;
  - (ii) the ability to relate their understanding of physics to other sciences and hence orient their knowledge and work towards multi-disciplinary/inter-disciplinary contexts and problems;
  - (iii) procedural knowledge that creates different types of professionals related to different areas of study in Physics and multi/interdisciplinary domains,
  - (iv) including research and development, teaching, technology professions, and government and public service;
  - (v) skills in areas of specializations of their elective subfields so that they can continue with higher studies and can relate their knowledge to current developments in those subfields.
- Use knowledge, understanding and skills required for identifying problems and issues relating to Physics, and its interface with other subjects studied in the course; collect relevant quantitative and/or qualitative data from a wide range of sources including various research laboratories of the world, and do analysis and evaluation using appropriate methodologies.
- Communicate the results of studies undertaken accurately in a range of different contexts using the main concepts, constructs and techniques of Physics and other subjects studied in the course. Develop communication abilities to present these results in technical as well as popular science meetings.
- Ability to meet their own learning needs, drawing on a range of pedagogic

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material available on the internet and books, current research and development work and professional materials, and in interaction with other science professionals.

- Demonstrate Physics-related technological skills that are relevant to Physics-related trades and employment opportunities.
- Apply their knowledge, understanding and skills to new/unfamiliar contexts beyond Physics to identify and analyze problems and issues, and to solve complex problems.

PROGRAMME LEARNING OUTCOMES IN B.SC. PHYSICS (HONS.)

Students graduating with the B.Sc. (Honours) Physics degree should be able to

- **Acquire**
  - (i) a fundamental/systematic and coherent understanding of the academic field of basic Physics in areas like Mechanics, Electricity and Magnetism, Waves and Optics, Thermal and Statistical Physics, Quantum Mechanics, Mathematical Physics and their applications to other core subjects in Physics;
  - (ii) a wide ranging and comprehensive experience in physics laboratory methods in experiments related to mechanics, optics, thermal physics, electricity, magnetism, digital electronics, solid state physics and modern physics. Students should acquire the ability for systematic observations, use of scientific research instruments, analysis of observational data, making suitable error estimates and scientific report writing;
  - (iii) 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;
  - (iv) knowledge and skills in areas related to their specialization area corresponding to elective subjects within the disciplinary/subject area of Physics and current and emerging developments in the field of Physics.
- Demonstrate the ability to use skills in Physics and its related areas of technology for 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. Recognize the importance of mathematical modelling, simulation and computational methods, and the role of approximation and mathematical approaches to describing the physical world and beyond.
- Plan and execute Physics-related experiments or investigations, analyze 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.
- Demonstrate relevant generic skills and global competencies such as

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(i) problem-solving skills that are required to solve different types of Physics related problems with well-defined solutions, and tackle open-ended problems that belong to the disciplinary area boundaries;
(ii) investigative skills, including skills of independent investigation of Physics related issues and problems;
(iii) communication skills involving the ability to listen carefully, to read texts and research papers analytically and to present complex information in a concise manner to different groups/audiences of technical or popular nature;
(iv) analytical skills involving paying attention to detail and ability to construct logical arguments using correct technical language related to Physics and ability to translate them with popular language when needed;
(v) ICT skills;
(vi) personal skills such as the ability to work both independently and in a group.

- Demonstrate professional behaviour such as -
  (i) being objective, unbiased and truthful in all aspects of work and avoiding unethical, irrational behaviour such as fabricating, falsifying or misrepresenting data or committing plagiarism;
  (ii) the ability to identify the potential ethical issues in work-related situations;
  (iii) be committed to the free development of scientific knowledge and appreciation
  (iv) its universal appeal for the entire humanity;
  (v) appreciation of intellectual property, environmental and sustainability issues;
  (vi) promoting safe learning and working environment.

TEACHING LEARNING PROCESSES IN B.SC. (HONS.) PHYSICS

The teaching learning processes play the most important role in achieving the desired aims and objectives of the undergraduate programs in Physics. The LOCF framework emphasizes learning outcomes for every physics course and its associate components. This helps in identifying most suitable teaching learning processes for every segment of the curricula. Physics is basically an experimental science with a very elaborate and advanced theoretical structure. Systematic observations of controlled experiments can open up windows to hidden properties and laws of nature. Physics concepts and theories are meant to create a systematic understanding of these properties and laws. All principles and laws of physics are accepted only after their verification and confirmation in laboratory, or observations in the real world, which requires scientists trained in appropriate experimental techniques, and engineers to design and make advanced scientific instruments. At the same time physics graduates also need a deep understanding of physics concepts, principles and theories, which require familiarity with different branches of mathematical physics. To achieve these goals, the appropriate training of young individuals to become competent scientists, researchers and engineers in future has to be accomplished. For this purpose, a very good undergraduate program in Physics is required as a first step. An

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appropriate teaching-learning procedure protocol for all the colleges is therefore essential. To be specific, it is desirable to have:

- Sufficient number of teachers in permanent positions to do all the class room teaching and supervise the laboratory experiments to be performed by the students.
- All teachers should be qualified as per the UGC norms and should have good communication skills.
- Sufficient number of technical and other support staff to run laboratories, libraries, and other equipment and to maintain the infrastructural facilities like buildings, ICT infrastructure, electricity, sanitation, etc.
- Necessary and sufficient infrastructural facilities for the class rooms, laboratories and libraries.
- Modern and updated laboratory equipment needed for the undergraduate laboratories and reference and text books for the libraries.
- Sufficient infrastructure for ICT and other facilities needed for technology enabled learning like computer facilities with all the necessary software.

Teachers should make use of these approaches for an efficient teaching-learning process:

- Class room teaching with lectures using traditional as well as electronic boards.
- Demonstration of the required experiments in laboratory and sessions on necessary apparatuses, data analysis, error estimation and scientific report writing for effective and efficient learning of laboratory techniques.
- Imparting the problem-solving ability which enables a student to apply physical and mathematical concepts to a new and concrete situation is essential to all courses. This can be accomplished through examples discussed in the class or laboratory, assignments and tutorials.
- CBCS curriculum has introduced a significant content of computational courses. Computational physics should be used as a new element in the physics pedagogy, and efforts should be made to introduce computational problems, including simulation and modelling, in all courses.
- Teaching should be complimented with students' seminar to be organized very frequently.
- Guest lectures and seminars should be arranged by inviting eminent teachers and scientists.
- Open-ended project work can be given to all students individually, or in groups of 2-3 students depending upon the nature of the course.
- Since actual undergraduate teaching is done in affiliated colleges which have differing levels of infrastructure and student requirements, the teachers should attend workshops organized by the University Department for college faculty on teaching methodology, reference materials, latest laboratory equipment and experiments, and computational physics software for achieving uniform standards. Common guidelines for individual courses need to be followed/evolved.
- Internship of duration varying from one week anytime in the semester, and/or 2-6 weeks during semester break and summer breaks can be arranged by the college for the students to visit other colleges/universities/HEI and industrial organizations in the vicinity.

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- Special attempts should be made by the institution to develop problem-solving skills and design of laboratory experiments for demonstration at the UG level. For this purpose, a mentor system may be evolved.
- Teaching load should be managed such that the teachers have enough time to interact with the students to encourage an interactive/participative learning.

In the first-year students are fresh from school. Given the diversity of their backgrounds, and the lack of adequate infrastructure and training in science learning in many schools, special care and teacher attention is essential in the first year. Mentorship with senior students and teachers can help them ease into rigors of university level undergraduate learning.

A student completing the Physics (Hons.) course under the CBCS takes 14 core courses, 4 discipline specific elective (DSE) courses, 4 general elective (GE) courses, four skill enhancement courses (SEC) and two ability enhancement compulsory courses (AECC). Since different categories of courses have different objectives and intended learning outcomes, the most efficient and appropriate teaching learning processes would not be same for all categories of courses.

ASSESSMENT METHODS

In the undergraduate education of Physics, the assessment and evaluation methods focus on testing the conceptual understanding of the basic ideas, enhanced mathematical skills, gained experimental techniques and ability to apply the knowledge acquired to explain finding as well as to solve new problems.

Going a step ahead of our traditional curriculum, more importance is to be given in problem solving than the textbook derivation in the theory examinations. Continuous evaluation of students in laboratory work and testing them on extension of experiments they have already performed can give more faithful evaluation of their laboratory skills.

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STRUCTURE OF COURSES IN B.SC. (HONS.) PHYSICS

The B.Sc. (Hons.) Physics programme consists of 148 credits based on the Choice Based Credit System (CBCS) prescribed by UGC and approved by Rajiv Gandhi University. The 148 credits include 84 credits of Core Courses (CC) and 8 credits of Ability Enhancement Compulsory Courses (AECC) which are mandatory. Choice is provided through 24 credits of Discipline Specific Electives (DSE), 8 credits of Skill Enhancement Courses (SEC) and 24 credits of Generic Elective Courses (GEC). The GEC are to be chosen exclusively by the students of other Science and Technology desciplines.

Semester	**Core Courses (CC)** • 14 CC are there • Compulsory • ***6 credits*** each	**Discipline Specific Elective (DSE)** • 5th sem.: 2 DSE • 6th sem.: 2 DSE • ***6 credit*** each	**Generic Elective (GE)** • 4 GEC are form the selected disciple** • ***6 credit*** each	**Ability Enhancement Core Course (AECC)** • 2 AECC are there • ***4 Credit*** each	**Skill Enhancement Course (SEC)** • 4 AEEC(SEC) courses • ***2 credit*** each	**Credit**
1	PHY-CC-111 PHY-CC-112		GEC -1	AECC- 1	SEC- 1	**24**
2	PHY-CC-121 PHY-CC-122		GEC -2	AECC -2	SEC- 2	**24**
3	PHY-CC-231 PHY-CC-232 PHY-CC-233		GEC -3		SEC- 3	**26**
4	PHY-CC-241 PHY-CC-242 PHY-CC-243		GEC -4		SEC- 4	**26**
5	PHY-CC-351 PHY-CC-352	DSE 1 DSE 2				**24**
6	PHY-CC-361 PHY-CC-362	DSE 3 DSE 4				**24**
Credit	**84**	**24**	**24**	**08**	**08**	**148**

***selected disciple for Physics(Hons.) : Chemistry, Mathematics, Computer Science*

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Seme-ster	Course Code	Course Name	Credit			
			L	T	P	Total
1st	PHY-CC-111	Mathematical Physics-I	4	0	2	6
	PHY-CC-112	Mechanics	4	0	2	6
	XXX-AE-111	Ability Enhancement Core Course 1 (ENG-AE-111 or HIN-AE-111)	4	0	0	4
	XXX-SE-$$$	Skill Enhancement Course (SEC 1)	-	-	-	2
	XXX-GE-$$$	Generic Elective 1 (GE 1)	-	-	-	6
2nd	PHY-CC-121	Electricity and Magnetism	4	0	2	6
	PHY-CC-122	Waves and Optics	4	0	2	6
	EVS-AE-121	Ability Enhancement Core Course 2 (AECC 2)	4	0	0	2
	XXX-SE-$$$	Skill Enhancement Course (SEC 2)	-	-	-	2
	XXX-GE-$$$	Generic Elective 2 (GE 2)	-	-	-	6
3rd	PHY-CC-231	Mathematical Physics–II	4	0	2	6
	PHY-CC-232	Thermal Physics	4	0	2	6
	PHY-CC-233	Analog Systems & Applications	4	0	2	6
	XXX-SE-$$$	Skill Enhancement Course (SEC 3)	-	-	-	2
	XXX-GE-$$$	Generic Elective 3 (GE 3)	-	-	-	6
4th	PHY-CC-241	Mathematical Physics–III	4	0	2	6
	PHY-CC-242	Elements of Modern Physics	4	0	2	6
	PHY-CC-243	Digital Systems and Applications	4	0	2	6
	XXX-SE-$$$	Skill Enhancement Course (SEC 4)	-	-	-	2
	XXX-GE-$$$	Generic Elective 4 (GE 4)	-	-	-	6
5th	PHY-CC-351	Quantum Mechanics and Applications	4	0	2	6
	PHY-CC-352	Solid State Physics	4	0	2	6
	PHY-DE-35$	Discipline Specific Elective (DSE 1)	-	-	-	6
	PHY-DE-35$	Discipline Specific Elective (DSE 2)	-	-	-	6
6th	PHY-CC-361	Electromagnetic Theory	4	0	2	6
	PHY-CC-362	Statistical Mechanics	4	0	2	6
	PHY-DE-36$	Discipline Specific Elective (DSE 3)	-	-	-	6
	PHY-DE-36$	Discipline Specific Elective (DSE 4)	-	-	-	6

Discipline Specific Elective (DSE)

Seme-ster	Course Code	Course Name	Credit			
			L	T	P	Total
5th (DSE 1 and DSE2)	PHY-DE-353	Classical Mechanics	5	1	0	6
	PHY-DE-354	Advanced Mathematical Physics	5	1	0	6
	PHY-DE-355	Electronic Devices and Communication	4	0	2	6
	PHY-DE-356	Physics of Earth	5	1	0	6
	PHY-DE-357	Experimental Techniques	4	0	2	6
	PHY-DE-358	Biological Physics	5	1	0	6
6th (DSE 3 and DSE 4)	PHY-DE-363	Nuclear and Particle Physics	5	1	0	6
	PHY-DE-364	Communication Electronics	4	0	2	6
	PHY-DE-365	Atmospheric Physics	4	0	2	6
	PHY-DE-366	Nano Materials and Applications	4	0	2	6
	PHY-DE-367	Astronomy and Astrophysics	5	1	0	6
	PHY-DE-368	Dissertation	0	0	6	6
	PHY-DE-369	Laboratory Physics	0	0	6	6

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Courses for B.Sc. Physics (Hons.) and its component

(A) Core Courses for Physics (Hons)

There are fourteen (14) compulsory core courses for Physics(H) and for each course associated with practical component.

SL. No.	Course Code	Type of course component	Name of the course component	Credit	Semester
1	PHY CC 111	Theory	Mathematical Physics-I	4	1st
		Practical	Physics Laboratory I	2	
2	PHY CC 112	Theory	Mechanics	4	
		Practical	Physics Laboratory II	2	
3	PHY CC 121	Theory	Electricity and Magnetism	4	2nd
		Practical	Physics Laboratory III	2	
4	PHY CC 122	Theory	Waves and Optics	4	
		Practical	Physics Laboratory IV	2	
5	PHY CC 231	Theory	Mathematical Physics – II	4	3rd
		Practical	Physics Laboratory V	2	
6	PHY CC 232	Theory	Thermal Physics	4	
		Practical	Physics Laboratory VI	2	
7	PHY CC 233	Theory	Analog Systems & Applications	4	
		Practical	Physics Laboratory VII	2	
8	PHY CC 241	Theory	Mathematical Physics–III	4	4th
		Practical	Physics Laboratory VIII	2	
9	PHY CC 242	Theory	Elements of Modern Physics	4	
		Practical	Physics Laboratory IX	2	
10	PHY CC 243	Theory	Digital Systems and Applications	4	
		Practical	Physics Laboratory X	2	
11	PHY CC 351	Theory	Quantum Mechanics and Applications	4	5th
		Practical	Physics Laboratory XI	2	
12	PHY CC 352	Theory	Solid State Physics	4	
		Practical	Physics Laboratory XII	2	
13	PHY CC 361	Theory	Electromagnetic Theory	4	6th
		Practical	Physics Laboratory XIII	2	
14	PHY CC 362	Theory	Statistical Mechanics	4	
		Practical	Physics Laboratory XIV	2	

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(B) Discipline Specific Elective (DSE) for Physics (Hons.)

Physics department of a college can offer a number of DSE courses as per their convenience form the prescribed list below and student has chosen two courses in the 5th semester and two courses in the 6th semester of their choice form courses offered by the college. Different college affiliated to Rajiv Gandhi University can offer different elective courses and be decided in the departmental meeting.

SL. No	Course code	Type of course component	Name of the course component	Credit	Semester
1	PHY DE 353	Theory	Classical Mechanics	6	**5th DSE1 and DSE 2** one has to choose any two from these six courses
2	PHY DE 354	Theory	Advanced Mathematical Physics	6	
3	PHY DE 355	Theory	Electronic Devices and Communication	4	
		Practical	Electronic Devices and Communication Laboratory	2	
4	PHY DE 356	Theory	Physics of Earth	6	
5	PHY DE 357	Theory	Experimental Techniques	4	
		Practical	Experimental Techniques Laboratory	2	
6	PHY DE 358	Theory	Biological Physics	6	
7	PHY DE 363	Theory	Nuclear and Particle Physics	6	**6th DSE 3 and DSE 4** one has to choose any two from these six courses. choice is restricted between PHY-DE-368 or PHY-DE 369
8	PHY DE 364	Theory	Communication Electronics	4	
		Practical	Communication Electronics Laboratory	2	
9	PHY DE 365	Theory	Atmospheric Physics	4	
		Practical	Atmospheric Physics Laboratory	2	
10	PHY DE 366	Theory	Nano Materials and Applications	4	
		Practical	Nano Material and applications Laboratory	2	
11	PHY DE 367	Theory	Astronomy and Astrophysics	6	
12	PHY DE 368	Theory	Dissertation	6	
13	PHY DE 369	Practical	Laboratory Physics		

Any one of these two

(C) Skill Enhancement Elective Course (SEC)

Physics Department offers these courses which are open for all science department

SL. No.	Course Code	Type of course component	Name of the course component	Credit	Semester
1	PHY SE 001	Theory	Basics of electronic circuits	1	1st and 3rd semester
	PHY SE 001	Practical	Electronic Circuits Laboratory	1	
2	PHY SE 002	Theory	Renewable energy and energy harvesting	1	
	PHY SE 002	Practical	Project on Renewable Energy	1	
3	PHY SE 003	Theory	Scientific writing through Latex	1	
	PHY SE 003	Practical	Project on Latex	1	
4	PHY SE 004	Theory	Space Physics	1	2nd and 4th semester
	PHY SE 004	Practical	Project on Space Physics	1	
5	PHY SE 005	Theory	Electronics in daily life	1	
	PHY SE 005	Practical	Project on Electronic Appliances	1	
6	PHY SE 006	Theory	Electric and Hybrid Vehicles	1	
	PHY SE 006P	Practical	Project on Electric Vehicles	1	

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Generic Courses **details for other discipline**

Generic Courses of Physics: (6 credit)

There are four courses for Hons. Student from other discipline, who can choose these as his/her generic electives in the first four sesmeter.

SL. No.	Course Code	Course component	Name of the course component	Credit	Seme -ster
1	PHY GE 001	Theory	Mechanics	4	1st or 3rd
		Practical	Generic Physics Laboratory 1	2	
2	PHY GE 002	Theory	Electricity and Magnetism	4	2nd or 4th
		Practical	Generic Physics Laboratory 2	2	
3	PHY GE 003	Theory	Waves and Optics	4	1st or 3rd
		Practical	Generic Physics Laboratory 3	2	
4	PHY GE 004	Theory	Thermal Physics and Statistical Mechanics	4	2nd or 4th
		Practical	Generic Physics Laboratory 4	2	

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PHY-CC-111 : MATHEMATICAL PHYSICS I

Credit: 4 (L- 4:T- 0: P-0) Theory: 60 Lectures

COURSE OBJECTIVES

The emphasis of course is to equip students with the mathematical and critical skills required in solving problems of interest to physicists. The course will also expose students to fundamental computational physics skills enabling them to solve a wide range of physics problems. The skills developed during course will prepare them not only for doing fundamental and applied but also for a wide variety of careers.

COURSE LEARNING OUTCOME

- Revise the knowledge of calculus and vector calculus, probability. These basic mathematical structures are essential in solving problems in various branches of Physics.
- Learn the curvilinear coordinates which have applications in problems with spherical and cylindrical symmetries.
- Learn the basic properties of matrices, different types of matrices viz., Hermitian, skew Hermitian, orthogonal and unitary matrices and their correspondence to physical quantities. They will also learn how to find the eigenvalues and eigenvectors of matrices.
- In the laboratory course, learn the fundamentals of the C programming languages and their applications in solving simple mathematical as well as physical problems.
- In the laboratory course, the students are expected to solve the problems using the Scilab/C.

BROAD CONTENTS OF THE COURSE

- Calculus
- Vector Calculus
- Orthogonal Curvilinear Coordinates
- Matrices

SKILLS TO BE LEARNED

- Training in calculus will prepare the student to solve various mathematical problems.
- He / she shall develop an understanding of how to formulate a physics problem and solve given mathematical equation risen out of it.

DETAILED CONTENTS OF THE COURSE

MODULE 1

Calculus: First Order Differential Equations and Integrating Factor. Homogeneous Equations with constant coefficients. Wronskian and general solution. Statement of existence and Uniqueness Theorem for Initial Value Problems. Particular Integral. **(13 Lectures)**

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Calculus of functions of more than one variable: Partial derivatives, exact and inexact differentials. Integrating factor, with simple illustration. **(2 Lectures)**

MODULE 2

Fundamental of Vector Calculus: Properties of vectors under rotations. Scalar product and its invariance under rotations. Vector product, Scalar triple product and their physical interpretation Scalar and Vector fields. **(5 Lectures)**

Vector Differentiation: Directional derivatives and normal derivative. Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field. Del and Laplacian operators. Vector identities. **(8 Lectures)**

MODULE 3

Vector Integration: Ordinary Integrals of Vectors. Multiple integrals, Jacobian. Notion of infinitesimal line, surface and volume elements. Line, surface and volume integrals of Vector fields. Flux of a vector field. Gauss' divergence theorem, Green's and Stokes Theorems and their applications (no rigorous proofs). **(15 Lectures)**

MODULE 4

Orthogonal Curvilinear Coordinates: Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems. **(6 Lectures)**

Matrices: Addition and Multiplication of Matrices. Null Matrices. Diagonal, Scalar and Unit Matrices. Upper-Triangular and Lower-Triangular Matrices. Transpose of a Matrix. Symmetric and Skew-Symmetric Matrices. Conjugate of a Matrix. Hermitian and Skew-Hermitian Matrices. Singular and Non-Singular matrices. Orthogonal and Unitary Matrix. Trace of a Matrix. Inner Product. Eigen-values and Eigenvectors. **(8 Lectures)**

TEXT BOOKS

1. Mathematical Physics, H.K. Dass and R. Verma, S. Chand & Company.
2. Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013, 7th Edn., Elsevier.

REFERENCE BOOKS

1. An introduction to ordinary differential equations, E.A. Coddington, 2009, PHI learning.
2. Differential Equations, George F. Simmons, 2007, McGraw Hill.
3. Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.
4. Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Book.
5. Advanced Engineering Mathematics, D.G. Zill and W.S. Wright, 5 Ed., 2012, Jones and Bartlett Learning.
6. Mathematical Physics, Goswami, 1st edition, Cengage Learning.
7. Engineering Mathematics, S.Pal and S.C. Bhunia, 2015, Oxford University Press.
8. Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
9. Essential Mathematical Methods, K.F.Riley & M.P.Hobson, 2011, Cambridge Univ. Press.
10. Mathematical Physics, H.K. Dass and R. Verma, S. Chand & Company.

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PHY-CC-111 (Practical) : PHYSICS LABORATORY - I

Credit:2 (L- 0:T- 0: P-2) Practical: 60 Hours

COURSE OBJECTIVES

The aim of this Lab is not just to teach computer programming and numerical analysis but to emphasize their role in solving problems in Physics. The course will also highlight the use of computational methods to solve physical problems. The major objectives of this Laboratory course are

- Highlights the use of computational methods to solve physical problems.
- Aiming to teach students to construct the computational problem to be solved.
- The list of programs presented here is only suggestive. Students should be encouraged to do more practice. Emphasis should be given to assess student's ability to formulate a physics.
- Transforming the problem as mathematical one and then solve by computational methods.

COURSE LEARNING OUTCOME

- Learn the basics of C programming theoretically and practically.
- Get a basic idea about the way of solving problems using C programming.
- Learn the use of C programming for a few numbers of Numerical techniques.

BROAD CONTENTS OF THE COURSE

- Basic of C programming.
- Application Numerical techniques using C programming.

SKILLS TO BE LEARNED

- Computer programming and numerical analysis.
- Solving of various problems of physics using the computational route.

CONTENTS OF LABORATORY EXPERIMENT

Introduction and Overview: Computer architecture and organization, memory and Input/output devices

Basics of scientific computing: Binary and decimal arithmetic, Floating point numbers, single and double precision arithmetic, underflow and overflow - emphasize the importance of making equations in terms of dimensionless variables, Iterative methods.

Errors and error Analysis: Truncation and round off errors, Absolute and relative errors, Floating point computations.

Review of C Programming fundamentals: Introduction to Programming, constants, variables and data types, operators and Expressions, I/O statements, scanf and printf, c in and c out, Manipulators for data formatting, Control statements (decision making and looping statements) (If-statement. If-else Statement. Nested if Structure. Else-if Statement. Ternary Operator. Goto Statement. Switch Statement.

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Unconditional and Conditional Looping. While Loop. Do-While Loop. FOR Loop. Break and Continue Statements. Nested Loops), Arrays (1D & 2D) and strings, user defined functions, Structures and Unions, Idea of classes and objects.

Random number generation: Area of circle, area of square, volume of sphere, value of pi (π)

Maclaurin and Taylor's Series: Approximate functions like $\sin(x)$, $\cos(x)$by a finite number of terms of Taylor's series

Solution of Algebraic and Transcendental equations by Bisection, Newton Raphson and Secant methods: Solution of linear and quadratic equation, Solving $\alpha = \tan\alpha$ and $I = I_0\left[\frac{\sin\alpha}{\alpha}\right]^2$

TEXT BOOKS

1. Programming in C by Balguruswamy (7ed,2007)McGraw-Hill.
2. Introduction to Numerical Analysis, S.S. Sastry, 5th Edn., 2012, PHI Learning Pvt. Ltd.

REFERENCE BOOKS

1. Schaum's Outline of Programming with C++, J. Hubbard, 2000, McGraw-Hill Pub.
2. Numerical Recipes in C: The Art of Scientific Computing, W.H. Pressetal, 3rd Edn. , 2007, Camb. Univ. Press.
3. A first course in Numerical Methods, U.M. Ascher & C. Greif, 2012, PHI Learning.
4. Elementary Numerical Analysis, K.E. Atkinson, 3 r d E d n . , 2 0 0 7 , Wiley India Edition.
5. Numerical Methods for Scientists & Engineers, R.W. Hamming, 1973, Courier Dover Pub.
6. An Introduction to computational Physics, T.Pang, 2nd Edn. , 2006, Cambridge Univ. Press.
7. Computational Physics, Darren Walker, 1st Edn., 2015, Scientific International Pvt. Ltd.

ASSESSMENT: MARKING SCHEME

Total Marks: 50

- **Internal assessment:** 10 marks
- **End term examination:** 40 (A laboratory examination will be conducted at the semester end).
  - Laboratory Notebook: 10 Marks
  - Experimental work and data analysis:10 Marks
  - Presentation and Viva voce: 20 Marks

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PHY-CC-112 : MECHANICS

Credit: 4 (L- 4:T- 0: P-0) Theory: 60 Lectures

COURSE OBJECTIVES

This course reviews the concepts of mechanics learnt at school from a more advanced perspective and goes on to build new concepts. It begins with Newton's Laws of Motion and ends with the Fictitious Forces and Special Theory of Relativity. Students will also appreciate the Collisions in CM Frame, Gravitation, Rotational Motion and Oscillations. The students will be able to apply the concepts learnt to several real-world problems.

COURSE LEARNING OUTCOME

After going through the course, the student should be able to

- Understand laws of motion and their applications. He / she will learn the concept of conservation of energy, momentum, angular momentum to apply them to basic problems.
- Understand the analogy between translational and rotational dynamics, and application of both motions simultaneously in analyzing rolling with slipping.
- Write the expression for the moment of inertia about the given axis of symmetry for different uniform mass distributions.
- Understand the phenomena of collisions and idea about center of mass and laboratory frames and their correlation.
- Apply Kepler's law to describe the motion of planets and satellite in circular orbit, through the study of law of Gravitation.
- Explain the phenomena of simple harmonic motion and the properties of such systems.
- Describe how fictitious forces arise in a non-inertial frame, e.g., why a person sitting in a merry-go-round experiences an outward pull.
- Describe special relativistic effects and their effects on the mass and energy of a moving object.
- In the laboratory course, the student shall perform experiments related to mechanics (compound pendulum), rotational dynamics (Flywheel), elastic properties (Young Modulus and Modulus of Rigidity), fluid dynamics (verification of Stokes law, Searle method), etc.

BROAD CONTENTS OF THE COURSE

- Fundamental of Dynamics
- Work and Energy
- Collisions
- Rotational Dynamics
- Elasticity
- Fluid Motion

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- Gravitation and cathode force Motion
- Oscillation
- Non-inertial Systems
- Special Theory of Relativity

SKILLS TO BE LEARNED

- Learn basics of the kinematics and dynamics linear and rotational motion.
- Learn the concepts of elastic in constant of solids and viscosity of fluids.
- Develop skills to understand and solve the equations of Newtonian Gravity and central force problem.
- Acquire basic knowledge of oscillation.
- Learn about inertial and non-inertial systems and essentials of special theory of relativity.

DETAILED CONTENTS OF THE COURSE

MODULE 1

Fundamentals of Dynamics: Momentum of variable-mass system: motion of rocket. Motion of a projectile in Uniform gravitational field Dynamics of a system of particles. Centre of Mass. Principle of conservation of momentum. Impulse. **(5 Lectures)**

Work and Energy: Work and Kinetic Energy Theorem. Conservative and non-conservative forces. Potential Energy. Energy diagram. Stable and unstable equilibrium. Elastic potential energy. Force as gradient of potential energy. Work & Potential energy. Work done by non- conservative forces. Law of conservation of Energy. **(6 Lectures)**

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

MODULE 2

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

Elasticity: Relation between the three elastic constants. Twisting torque on a Wire. **(3 Lectures)**

MODULE 3

Gravitation and Central Force Motion: Motion of a particle under a central force field. Two-body problem and its solution. The energy equation and energy diagram. Kepler's Laws. Satellite in circular orbit Geosynchronous orbits. Weightlessness. (**8 Lectures)**

Oscillations: Differential equation of simple harmonic motion and its solution. Kinetic energy, potential energy, total energy. Damped oscillation. Forced oscillations: Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor. **(7 Lectures)**

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MODULE 4

Inertial and Non-Inertial Systems: Inertial frames; Galilean transformations; Galilean invariance. Non-inertial frames and fictitious forces. Uniformly rotating frame. Laws of Physics in rotating coordinate systems. Centrifugal force. **(5 Lectures)**

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

TEXT BOOKS

1. Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000.
2. An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.
3. Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill.

REFERENCES

1. Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.
2. Analytical Mechanics, G.R. Fowles and G.L. Cassiday. 2005, Cengage Learning.
3. Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education.
4. Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
5. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
6. University Physics. F.W Sears, M.W Zemansky, H.D Young 13/e, 1986, Addison Wesley.
7. Physics for scientists and Engineers with Modern Phys., J.W. Jewett, R.A. Serway, 2010, Cengage Learning.
8. Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.

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PHY-CC-112 (Practical): PHYSICS LABORATORY- II

Credit: 2 (L- 0:T- 0: P-2) Practical: 60 Hours

COURSE OBJECTIVES

The aim of this Laboratory is to understand some of the basic phenomenon of mechanics through various experiment. Another prime objective of the course is to enhance the scientific data collection and analysis in Physics Laboratories.

COURSE LEARNING OUTCOME

- Learn use of Vernier calipers, screw gauge and travelling microscope, and necessary precautions during the different experiments.
- Learn basics about the errors, their propagation and recording in final result up to correct significant digits.
- Learn the linearization of data and the use of slope and intercept to determine unknown quantities.
- Way of writing of scientific laboratory reports, which may include theoretical and practical significance of the experiment performed, apparatus description, relevant theory, necessary precautions to be taken during the experiment, proper recording of observations, data analysis, estimation of the error and explanation of its sources, correct recording of the result of the experiment, and proper referencing of the material taken from other sources (books, websites, research papers, etc.)

SKILLS TO BE LEARNED

- Use of various types of measuring instruments used in Physics Laboratories.
- Skill to use of graph between two different physical quantities to calculate an unknown quantity.
- Art of scientific report wringing of laboratory work.

LIST OF EXPERIMENTS

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 study the Motion of Spring and calculate (a) Spring constant, (b) gravitational constant and (c) Modulus of rigidity.
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 Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).

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8. To determine the Young's Modulus of a Wire by Optical Lever Method.
9. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
10. To determine the elastic Constants of a wire by Searle's method.
11. To determine the value of g using Bar Pendulum.
12. To determine the value of g using Kater's Pendulum.

TEXT BOOKS

1. A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Edn, 2011, Kitab Mahal.
2. Engineering Practical Physics, S.Panigrahi & B.Mallick,2015, Cengage Learning India Pvt. Ltd.

REFERENCE BOOKS

1. Advanced Practical Physics for students, B. L. Flint, H.T. Worsnop, 1971, Asia Pub. House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn,
3. Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.

ASSESSMENT: MARKING SCHEME

Total Marks: 50

- **Internal assessment:** 10 marks
- **End term examination:** 40 (A laboratory examination will be conducted at the semester end).
  - Laboratory Notebook: 10 Marks
  - Experimental work and data analysis:10 Marks
  - Presentation and Viva voce: 20 Marks

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PHY-CC-121 : ELECTRICITY AND MAGNETISM

Credit: 4 (L- 4:T- 0: P-0) Theory: 60 Lectures

COURSE OBJECTIVES

This course reviews the concepts of electromagnetism learnt at school from a more advanced perspective and goes on to build new concepts. The course covers static and dynamic electric and magnetic fields, and the principles of electromagnetic induction. It also includes analysis of electrical circuits and introduction of network theorems. The students will be able to apply the concepts learnt to several real-world problems.

COURSE LEARNING OUTCOME

After going through the course, the student should be able to

- Demonstrate Gauss law for the electric field, and apply it to systems of point charges as well as line, surface, and volume distributions of charges.
- Explain and differentiate the vector (electric fields, Coulomb's law) and scalar (electric potential, electric potential energy) formalisms of electrostatics.
- Apply Gauss's law of electrostatics to solve a variety of problems.
- Articulate knowledge of electric current, resistance and capacitance in terms of electric field and electric potential.
- Demonstrate a working understanding of capacitors.
- Describe the magnetic field produced by magnetic dipoles and electric currents.
- Explain Faraday-Lenz and Maxwell laws to articulate the relationship between electric and magnetic fields.
- Understand the magnetic properties of materials and the phenomena of electromagnetic induction.
- Describe how magnetism is produced and list examples where its effects are observed.
- Apply Kirchhoff's rules to analyze AC circuits consisting of parallel and/or series combinations of voltage sources and resistors and to describe the graphical relationship of resistance, capacitor and inductor.
- In the laboratory course the student will get an opportunity to verify various laws in electricity and magnetism such as Lenz's law, Faraday's law and learn about the construction, working of various measuring instruments.
- Should be able to verify of various circuit laws, network theorems elaborated above, using simple electric circuits.

BROAD CONTENTS OF THE COURSE

- Electric Field and Electric Potential
- Conservative nature of Electrostatic Field
- Electrostatic energy of system of charges

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- Dielectric Properties of Matter
- Magnetic Field
- Magnetic Properties of Matter
- Electromagnetic Induction
- Electrical Circuits
- Network Theorems
- Ballistic Galvanometer

SKILLS TO BE LEARNED

- This course will help in understanding basic concepts of electricity and magnetism and their applications.
- Basic course in electrostatics will equip the student with required prerequisites to understand electrodynamics phenomena.

DETAILED CONTENTS OF THE COURSE

MODULE 1

Electric field: Electric field lines. Electric flux. Gauss' Law with applications to charge distributions with spherical, cylindrical and planar symmetry. **(7 Lectures)**

Conservative nature of Electrostatic Field: Laplace's and Poisson equations. The Uniqueness Theorem. Potential and Electric Field of a dipole. Force and Torque on a dipole. **(8 Lectures)**

MODULE 2

Electrostatic energy of system of charges. Electrostatic energy of a charged sphere. Conductors in an electrostatic Field. Surface charge and force on a conductor. Capacitance of charged conductors. Parallel-plate capacitor. Capacitance of an isolated conductor. Method of Images and its application to: (1) Plane Infinite Sheet and (2) Sphere. **(10 Lectures)**

Magnetic Properties of Matter: Magnetization(M). Magnetic Intensity (H). Magnetic Susceptibility and permeability. Relation between B, H, M. Ferromagnetism. B-H curve and hysteresis **. (5 Lectures)**

MODULE 3

Magnetic Field: Biot-Savart's Law and its applications: straight wire and circular loop. Current Loop as a Magnetic Dipole and its Dipole Moment, Ampere's Circuital Law and its application to (1) Solenoid and (2) Toroid. Properties of B: curl and divergence. Vector Potential. Magnetic Force on (1) point charge (2) current carrying wire (3) between current elements. Torque on a current loop in a uniform Magnetic Field. **(15 Lectures)**

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MODULE 4

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

Electrical Circuits: Kirchhoff's laws for AC circuits. Complex Impedance. Series LCR Circuit. Parallel LCR Circuit. **(5 Lectures)**

Ballistic Galvanometer: Torque on a current Loop. Ballistic Galvanometer: Current and Charge Sensitivity. Electromagnetic damping. Logarithmic damping. CDR. **(4 Lectures)**

TEXT BOOKS

1. Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn., 1998, Benjamin Cummings.
2. Electricity, Magnetism & Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw-Hill.

REFERENCE BOOKS

1. Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education
2. Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn., 1998, Benjamin Cummings.
3. Feynman Lectures Vol.2, R.P. Feynman, R.B. Leighton, M. Sands, 2008, Pearson Education.
4. Elements of Electromagnetics, M.N.O. Sadiku, 2010, Oxford University Press.
5. Electricity and Magnetism, J.H. Fewkes & J. Yarwood. Vol. I, 1991, Oxford Univ. Press.

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PHY-CC-121 (Practical) : PHYSICS LABORATORY- III

Credit: 2 (L- 0:T- 0: P-2)

Practical: 60 Hours

COURSE OBJECTIVES

Demonstration and practical laboratory experiments on electrical circuits and devices and uses of different electrical devices is the objective of the course. Moreover, raining on the review of experimental data analysis, sources of error and their estimation in detail, writing of scientific laboratory reports including proper reporting of errors is also an aim of the course.

COURSE LEARNING OUTCOME

In this laboratory-based course, student will learn

- The construction, functioning and uses of different electrical bridge circuits, and electrical devices like the ballistic galvanometer.
- linearization of data and the use of slope and intercept to determine unknown quantities.
- How to present their experimental data in a laboratory report.

SKILLS TO BE LEARNED

- Skills to design electronic circuit form circuit diagram.
- Use of various electronic instruments.
- Use of various types of measuring instruments used in Physics Laboratories.
- Art of scientific report wringing of laboratory work.

LIST OF EXPERIMNETS:

1. Use a Multimeter for measuring (a) Resistance, (b) AC and DC Voltage, (c) DC Current, (d) Capacitance, and (e) Checking electrical fuse.
2. To study the characteristics of a series RC Circuit.
3. To determine an unknown Low Resistance using Potentiometer.
4. To determine an unknown Low Resistance using Carey Foster's Bridge.
5. To compare capacitance using De' Sauty's bridge.
6. Measurement of field strength B and its variation in a solenoid (determine dB/dx).
7. To verify the Thevenin and Norton theorems.
8. To verify the Superposition, and Maximum power transfer theorems.
9. To determine self-inductance of a coil by Anderson's bridge.
10. To study response curve of a Series LCR circuit and determine its (a)Resonant frequency,

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(b) Impedance at resonance, (c) Quality factor Q, and (d) Band width.

11. To study the response curve of a parallel LCR circuit and determine its (a) Anti-resonant frequency and (b) Quality factor Q.
12. Measurement of charge and current sensitivity and CDR of Ballistic Galvanometer.
13. Determine a high resistance by leakage method using Ballistic Galvanometer.
14. To determine self-inductance of a coil by Rayleigh's method.
15. To determine the mutual inductance of two coils by Absolute method.

TEXT BOOKS

1. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Edn., 2011, Kitab Mahal.
2. Engineering Practical Physics, S. Panigrahi & B. Mallick, 2015, Cengage Learning India Pvt. Ltd.

REFERENCE BOOKS

1. Advanced Practical Physics for students, B. L. Flint, H.T. Worsnop, 1971, Asia Pub. House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn,
3. Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.

ASSESSMENT: MARKING SCHEME

Total Marks: 50

- **Internal assessment:** 10 marks
- **End term examination:** 40 marks (laboratory exam. will be conducted at the semester end).
  - Laboratory Notebook: 10 Marks
  - Experimental work and data analysis: 10 Marks
  - Presentation and Viva voce: 20 Marks

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PHY-CC-122: WAVES AND OPTICS

Credit: 4 (L- 4:T- 0: P-0) Theory: 60 Lectures

COURSE OBJECTIVES

This course reviews the concepts of waves and optics learnt at school from a more advanced perspective and goes on to build new concepts. It begins with explaining ideas of superposition of harmonic oscillations leading to physics of travelling and standing waves. The course also provides an in depth understanding of wave phenomena of light, namely, interference and diffraction with emphasis on practical applications of the same.

COURSE LEARNING OUTCOME

This course will enable the student to

- Recognize and use a mathematical oscillator equation and wave equation, and derive these equations for certain systems.
- Apply basic knowledge of principles and theories about the behavior of light and the physical environment to conduct experiments.
- Understand the principle of superposition of waves and formation of standing waves.
- Explain several phenomena we can observe in everyday life that can be explained as wave phenomena.
- Use the principles of wave motion and superposition to explain the Physics of polarisation, interference and diffraction.
- Understand the working of selected optical instruments like biprism, interferometer, diffraction grating, and holograms.
- In the laboratory course, student will gain hands-on experience of using various optical instruments and making finer measurements of wavelength of light using Newton Rings experiment, Fresnel Biprism etc. Resolving power of optical equipment can be learnt firsthand. The motion of coupled oscillators, study of Lissajous figures and behaviour of transverse, longitudinal waves can be learnt in this laboratory course.

BROAD CONTENTS OF THE COURSE

- Superposition of Two Collinear Harmonic Oscillations
- Superposition of Two Perpendicular Harmonic Oscillations
- Waves Motion – General
- Velocity of Waves
- Superposition of Two Harmonics Waves
- Wave Optics
- Interference
- Michelson's Interferometer
- Diffraction

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- Fraunhofer Diffraction
- Fresnel Diffraction
- Holography

SKILLS TO BE LEARNED

- He / she shall develop an understanding of various aspects of harmonic oscillations and waves specially- (a) Superposition of collinear and perpendicular harmonic oscillations (b) Various types of mechanical waves and their superposition.
- This course in basics of optics will enable the student to understand various optical phenomena, principles, workings and applications optical instruments.

DETAILED CONTENTS OF THE COURSE

MODULE 1

Superposition of Collinear Harmonic oscillations: Superposition of two collinear oscillations, Beats. Superposition of N collinear Harmonic Oscillations **(6 Lectures)**

Superposition of two perpendicular Harmonic Oscillations: Graphical and Analytical Methods. Lissajous Figures with equal an unequal frequency and their uses. **(3 Lectures)**

Wave Motion: Wave Equation. Particle and Wave Velocities. Differential Equation. Pressure of a Longitudinal Wave. Energy Transport. Water Waves: Ripple and Gravity Waves. **(6 Lectures)**

MODULE 2

Velocity of Waves: Velocity of Transverse Vibrations of Stretched Strings. Velocity of Longitudinal Waves in a Fluid in a Pipe. Newton's Formula for Velocity of Sound. Laplace's Correction. **(6 Lectures)**

Superposition of Two Harmonic Waves: Standing Waves in a String: Fixed and Free Ends. Phase and Group Velocities. Changes with respect to Position and Time. Transfer of Energy. Normal Modes of Stretched Strings. Plucked and Struck Strings. Melde's Experiment. Longitudinal Standing Waves and Normal Modes. Open and Closed Pipes. Superposition of N Harmonic Waves. **(7 Lectures)**

Wave Optics: Electromagnetic nature of light. Definition and properties of wave front. Huygens Principle. Temporal and Spatial Coherence. **(3 Lectures)**

MODULE 3

Interference: Young's double slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: Measurement of wavelength and refractive index. **(9 Lectures)**

Interferometer: Michelson Interferometer and its applications, Determination of wavelength, Refractive Index, Fabry-Perot interferometer **(4 Lectures)**

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MODULE 4

Diffraction: Kirchhoff's Integral Theorem (Qualitative discussion only) **(1 Lectures)**

Fraunhofer diffraction: Single slit. Circular aperture, Resolving Power of a telescope. Double slit. Multiple slits. Diffraction grating. Resolving power of grating. **(7 Lectures)**

Fresnel Diffraction: Fresnel's Assumptions. Fresnel's Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Fresnel's Integral, Fresnel diffraction pattern of a straight edge, a slit and a wire. **(8 Lectures)**

TEXT BOOKS

1. Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.
2. Optics, Ajoy Ghatak, 2008, Tata McGraw-Hill.

REFERENCE BOOKS

3. Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.
4. Fundamentals of Optics, F.A. Jenkins and H.E. White, 1981, McGraw-Hill.
5. Principles of Optics, Max Born and Emil Wolf, 7th Edn., 1999, Pergamon Press.
6. Optics, Ajoy Ghatak, 2008, Tata McGraw-Hill.
7. The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.
8. The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw-Hill.
9. Fundamental of Optics, A. Kumar, H.R. Gulati and D.R. Khanna, 2011, R. Chandublications.

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PHY-CC-122 (Practical) : PHYSICS LABORATORY - IV

Credit: 2 (L- 0:T- 0: P-2)

Practical: 60 Hours

COURSE OBJECTIVES

The main objective of this laboratory component is to understand the different phenomenon of optics through though laboratory experiments.

COURSE LEARNING OUTCOME

From various experiments in the course student will learn

- Use of spectrometer and lasers, and necessary precautions during the experiments.
- Sessions on the review of experimental data analysis, sources of error and their estimation in detail, writing of scientific laboratory reports including proper reporting of errors.
- linearization of data and the use of slope and intercept to determine unknown quantities.
- How to present their experimental data in a laboratory report.

SKILLS TO BE LEARNED

- Hand on experience on various light sources and spectrometer.
- Arrangement of optics related experimental set-up.
- Data analysis, error calculation and laboratory report preparation.

DETAILED CONTENTS OF THE COURSE

1. To determine the frequency of a tuning fork by Melde's experiment and verify λ^2 – T law.
2. To investigate the motion of coupled oscillators.
3. To study Lissajous Figures.
4. Familiarization with: Schuster`s focusing; determination of angle of prism.
5. To determine refractive index of the Material of a prism using sodium source.
6. To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.
7. To determine the wavelength of sodium source using Michelson's interferometer.
8. To determine wavelength of sodium light using Fresnel Biprism.
9. To determine wavelength of sodium light using Newton's Rings.
10. To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film.
11. To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating.
12. To determine dispersive power and resolving power of a plane diffraction grating.

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TEXT BOOKS

1. A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Edn, 2011, Kitab Mahal
2. A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, 1985, Vani Pub.

REFERENCE BOOKS

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal.
3. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.

ASSESSMENT: MARKING SCHEME

Total Marks: 50

- **Internal assessment:** 10 marks
- **End term examination:** 40 marks (laboratory exam. will be conducted at the semester end).
  - Laboratory Notebook: 10 Marks
  - Experimental work and data analysis: 10 Marks
  - Presentation and Viva voce: 20 Marks

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PHY-CC-231 : MATHEMATICAL PHYSICS - II

Credit: 4 (L- 4:T- 0: P-0) Theory: 60 Lectures

COURSE OBJETIVES

The emphasis of course is to equip students with the mathematical tools required in solving problems interest to physicists and expose them to fundamental computational physics skills thus enabling them to solve a wide range of physics problems. This course will aim at introducing the concepts of Fourier series, special functions, linear partial differential equations by separation of variable method.

COURSE LEARNING OUTCOME

- Learn about the special functions, such as the Hermite polynomial, the Legendre polynomial, the Laguerre polynomial and Bessel functions and their differential equations and their applications in various physical problems such as in quantum mechanics which they will learn in future courses in detail.
- Learn the Fourier analysis of periodic functions and their applications in physical problems such as vibrating strings etc.
- Acquire knowledge of methods to solve partial differential equations with the examples of important partial differential equations in Physics.
- In the laboratory course, learn the basics of the Scilab software, their utility, advantages and disadvantages.
- Apply the Scilab software in curve fittings, in solving system of linear equations, generating and plotting special functions such as Legendre polynomial and Bessel functions, solving first and second order ordinary and partial differential equations.

BROAD CONTENTS OF THE COURSE

- Special Functions
- Special Integrals
- Fourier Series
- Partial Differential Equation

SKILLS TO BE LEARNED

- Training in mathematical tools like calculus, integration, series solution approach, special function will prepare the student to solve ODE, PDE's which model physical phenomena.
- He / she shall develop an understanding of how to model a given physical phenomena such as pendulum motion, rocket motion, stretched string, etc., into set of ODE's, PDE's and solve them.
- These skills will help in understanding the behavior of the modeled system/s.

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DETAILED CONTENTS OF THE COURSE

MODULE 1

Frobenius Method and Special Functions: Singular Points of Second Order Linear Differential Equations and their importance. Frobenius method and its applications to differential equations. Legendre, Bessel, Hermite and Laguerre Differential Equations. **(15 Lectures)**

MODULE 2

Legendre Polynomials: Properties of Legendre Polynomials, Rodrigues Formula, Generating Function, Orthogonality. Simple recurrence relations. Expansion of function in a series of Legendre Polynomials. Bessel Functions of the First Kind: Generating Function, simple recurrence relations. Zeros of Bessel Functions($J_0(x)$ and $J_1(x)$) and Orthogonality. **(15 Lectures)**

MODULE 3

Some Special Integrals: Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. Error Function (Probability Integral). **(7 Lectures)**

Fourier Series: Periodic functions. Orthogonality of sine and cosine functions, Dirichlet Conditions (Statement only). Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients. **(8 Lectures)**

MODULE 4

Partial Differential Equations: Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular, cylindrical and spherical symmetry. Wave equation and its solution for vibrational modes of a stretched string, **(15 Lectures)**

TEXT BOOKS

1. Mathematical Physics, H.K. Dass and R. Verma, S. Chand & Company.
2. Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013, 7th Edn. Elsevier.

REFERENCE BOOKS

1. An introduction to ordinary differential equations, E.A. Coddington, 2009, PHI learning.
2. Differential Equations, George F. Simmons, 2007, McGraw Hill.
3. Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.
4. Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Book.
5. Advanced Engineering Mathematics, D.G. Zill and W.S. Wright, 5 Ed., 2012, Jones and Bartlett Learning.
6. Mathematical Physics, Goswami, 1st edition, Cengage Learning.
7. Engineering Mathematics, S.Pal and S.C. Bhunia, 2015, Oxford University Press.
8. Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
9. Essential Mathematical Methods, K.F.Riley & M.P.Hobson, 2011, Cambridge Univ. Press.

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PHY-CC-131 (Practical): PHYSICS LABORATORY- V

Credit: 2 (L- 0:T- 0: P-2)

Practical: 60 Hours

COURSE OBJECTIVES

The main objective of this course is to deploy computational methods to solve physical problem using scientific software like Scilab.

COURSE LEARNING OUTCOME

- Scilab software, their utility, advantages and disadvantages.
- Different computational techniques used to solve physics problems.
- to deploy the computational methods to solve physical problems

SKILLS TO BE LEARNED

- Use and programming in SciLab
- Solving of various problems of physics using the computational route.

DETAILED CONTENTS OF THE COURSE

Introduction Scilab: Introduction to Scilab, Advantages and disadvantages, Scilab environment, Command window, Figure window, Edit window, Variables and arrays, Initialising variables in Scilab, Multidimensional arrays, Subarray, Special values, Displaying output data, data file, Scalar and array operations, Hierarchy of operations, Built in Scilab functions, Introduction to plotting, 2D and 3D plotting, Branching Statements and program design, Relational & logical operators, the while loop, for loop, details of loop operations, break & continue statements, nested loops, logical arrays and vectorization. User defined functions, Introduction to Scilab functions, Variable passing in Scilab, optional arguments, 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. Using Scilab based experiments is to be done various topic as listed below

- **Liner Algebra:** Multiplication of 3×3 matrices, Eigenvalue and Eigen value and Eigen vector, Inverse of a matrix.
- **Curve fitting, Least square fit, Goodness of fit, standard deviation:** Ohms law to calculate R,
- Hooke's law to calculate spring Constant.
- **Generation of Special functions using User defined functions in Scilab**: Generating and plotting Legendre Polynomials Generating and plotting Bessel function.
- **Interpolation by Newton Gregory Forward and Backward difference formula , Error estimation of linear interpolation.**
- **Lagrange Interpolation**: Evaluation of trigonometric functions e.g. sin(x), cos(x), tan(x) etc. – Given the values at n points in a tabulated form, evaluate the value at an intermediate point.

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- **Numerical Integration: Newton Cotes Integration methods (Trapezoidal and Simpson rules) for definite integrals**: Given acceleration with equidistant time data calculate position and velocity and plot them. Application to other mathematical and physical problems.
- **Solution of Linear system of equations by Gauss elimination method and Gauss Seidal method.**
- **Diagonalization of matrices, Inverse of a matrix, Eigenvectors, eigen values problems**: Solution of mesh equations of electric circuits (3 meshes) Solution of coupled spring mass systems (3 masses).
- **System of First order Differential Equations**: Attempt following problems using RK 4 order method:
  - Solve the coupled differential equations

    $\frac{dx}{dt} = y + x - \frac{x^3}{3}$; $\frac{dy}{dt} = -x$ for four initial conditions: $x(0) = 0, y(0) = -1, -2, -3, -4$

    Plot $x\ vs\ y$ for each of the four initial conditions
  - Solve the first order differential equation
    a) Radioactive decay
    b) Current in RC, LC circuits with DC source
    c) Newton's law of cooling
- **Second order differential equation (Euler and RK Methods):** Solve the differential equation of second order
    a) Classical equations of motion Second order Differential Equation
    b) Harmonic oscillator (no friction)
    c) Damped Harmonic oscillator
    d) Over damped
    e) Critical damped
    f) Oscillatory
    g) Forced Harmonic oscillator
    h) Transient and
    i) Steady state solution
- **Partial Differential equation:** Solution of
    a) Wave equation
    b) Heat equation
    c) Poisson equation
    d) Laplace equation

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- **Using Scicos / xcos**: Generating square wave, sine wave, saw tooth wave
    a) Solution to harmonic oscillator
    b) Study of beat phenomenon
    c) Phase space plots

TEXT BOOKS

1. Scilab by example: M. Affouf 2012, ISBN:978-1479203444.
2. Scilab (A free software to Matlab): H. Ramchandran, A.S. Nair., 2011, S. Chand & Company.
3. Scilab Image Processing: Lambert M. Surhone. 2010 Betascript Publishing.

REFERENCE BOOKS

1. Mathematical Methods for Physics and Engineers, K. FRiley, M.P. Hobsonand S. J. Bence, 3rd ed., 2006, Cambridge University Press Complex Variables, A.S. Fokas & M.J. Ablowitz, 8th Ed., 2011, Cambridge Univ. Press.
2. First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940, Jones &Bartlett
3. Computational Physics, D.Walker, 1st Edn., 2015, Scientific International Pvt. Ltd.
4. A Guide to MATLAB, B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, 2014, 3rd Edn., Cambridge UniversityPress
5. Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A.V. Wouwer, P. Saucez, C.V. Fernández., 2014, Springer
6. www.**scilab**.in/textbook_companion/generate_book/291.

ASSESSMENT: MARKING SCHEME

Total Marks: 50

- **Internal assessment:** 10 marks
- **End term examination:** 40 (A laboratory examination will be conducted at the semester end).
    - Laboratory Notebook: 10 Marks
    - Programming and problem solving : 15 Marks
    - Viva voce: 15 Marks

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PHY-CC-232 : THERMAL PHYSICS

Credit: 4 (L- 4:T- 0: P-0) Theory: 60 Lectures

COURSE OBJECTIVES

This course deals with the relationship between the macroscopic properties of physical systems in equilibrium. It reviews the concepts of thermodynamics learnt at school from a more advanced perspective and develops them further. The primary goal is to understand the fundamental laws of thermodynamics and their applications to various systems and processes. In addition, it will also give exposure to students about the Kinetic theory of gases, transport phenomena involved in ideal gases, phase transitions and behavior of real gases.

COURSE LEARNING OUTCOME

- Comprehend the basic concepts of thermodynamics, the first and the second law of thermodynamics, the concept of entropy and the associated theorems, the thermodynamic potentials and their physical interpretations.
- Learn about Maxwell's thermodynamic relations.
- Learn the basic aspects of kinetic theory of gases, Maxwell-Boltzman distribution law, equitation of energies, mean free path of molecular collisions, viscosity, thermal conductivity, diffusion and Brownian motion.
- Learn about the real gas equations, Van der Waal equation of state, the Joule-Thompson effect.
- In the laboratory course, the students are expected to do some basic experiments in thermal Physics, viz., determinations of Stefan's constant, coefficient of thermal conductivity, temperature coefficient of resistant, variation of thermo-emf of a thermocouple with temperature difference at its two junctions and calibration of a thermocouple.

BROAD CONTENTS OF THE COURSE

- Zeroth and First Law of Thermodynamics
- Second Law of Thermodynamics
- Entropy
- Thermodynamic Potentials
- Maxwell's Thermodynamic Relations
- Kinetic Theory of Gases : Distribution of Velocities Molecular Collisions Real Gases

SKILLS TO BE LEARNED

- This basic course in thermodynamics will enable the student to understand various thermo dynamical concepts, principles.

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DETAILED CONTENTS OF THE COURSE

MODULE 1

Zeroth and First Law of Thermodynamics: Extensive and intensive Thermodynamic Variables, Zeroth Law of Thermodynamics & Concept of Temperature, Concept of Work & Heat, State Functions, First Law of Thermodynamics, Isothermal and Adiabatic Processes- work done **(5 Lectures)**

Second Law of Thermodynamics: Reversible and Irreversible process, Carnot engine. Refrigerator & coefficient of performance, 2nd Law of Thermodynamics: different Statements. Carnot's Theorem. Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale. **(10 Lectures)**

MODULE 2

Entropy: Clausius Theorem. Second Law of Thermodynamics in terms of Entropy. Entropy of a perfect gas. Entropy Changes in Reversible and Irreversible processes with examples. Entropy of the Universe. Temperature–Entropy diagrams for Carnot's Cycle. Third Law of Thermodynamics. **(7 Lectures)**

Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy-Properties and Applications. Surface Films and Variation of Surface Tension with Temperature. Magnetic Work, Cooling due to adiabatic demagnetization, First and second order Phase Transitions with examples, Clausius Clapeyron Equation and Ehrenfest equations. **(8 Lectures)**

MODULE 3

Maxwell's Thermodynamic Relations: Derivations. Applications of Maxwell's Relations:(1) Clausius Clapeyron equation, (2) Values of Cp-Cv, (3) TdS Equations, (4) Joule-Kelvin coefficient for Ideal and Van der Waal Gases, (5) Energy equations, (6) Adiabatic Process. **(8 Lectures)**

Kinetic Theory of Gases: Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification. Doppler Broadening of Spectral Lines and Stern's Experiment. Degrees of Freedom. Law of Equipartition of Energy (No proof required). Specific heats of Gases. **(7 Lectures)**

MODULE 4

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

Real Gases: The Virial Equation. Andrew's Experiments on CO_2 Gas. Boyle Temperature. Van der Waal's Equation. Values of Critical Constants. Comparison with Experimental Curves. P-V Diagrams. Joule's Experiment. Free Adiabatic Expansion of a Perfect Gas. Joule-Thomson Effect for Real and Van der Waal Gases. Temperature of Inversion. Joule-Thomson Cooling. **(10 Lectures)**

TEXT BOOKS

1. Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill.
2. Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill

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REFERENCE BOOKS

1. A Treatise on Heat, Meghnad Saha, and B.N.Srivastava, 1958, Indian Press
2. Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.
3. Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa.
4. Concepts in Thermal Physics, S.J. Blundell and K.M. Blundell, 2nd Ed., 2012, Oxford University Press.
5. Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. Chand Publications.
6. Thermal Physics, B.K. Agrawal, Lok Bharti Publications.

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PHY-CC-232 (Practical) : PHYSICS LABORATORY - VI

Credit: 2 (L- 0:T- 0: P-2) Practical: 60 Hours

COURSE OBJECTIVES

Demonstration and practical laboratory experiments on to understand some basic concept and phenomenon of thermal physics.

COURSE LEARNING OUTCOME

- construction and use of specific measurement instruments and experimental apparatuses used in the thermal physics lab, including necessary precautions.
- Analysis of experimental data, error estimation and writing scientific reports.

SKILLS TO BE LEARNED

- Hand on experience on Thermal physics related phenomena.
- Arrangement of of experimental set-up related to thermal physics.
- Data analysis, error calculation and laboratory report preparation

DETAILED CONTENTS OF THE COURSE

1) To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
2) To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus.
3) To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.
4) To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method.
5) To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT).
6) To study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of its Two Junctions.
7) To calibrate a thermocouple to measure temperature in a specified Range using Null Method as well as Direct measurement and to determine Neutral Temperature.

TEXT BOOKS

1. A Laboratory Manual of Physics for undergraduate classes, D.P. Khandelwal, 1985, Vani Pub.

REFERENCE BOOKS

1. Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal.
3. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.

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ASSESSMENT: MARKING SCHEME

Total Marks: 50

- **Internal assessment:** 10 marks
- **End term examination:** 40 (A laboratory examination will be conducted at the semester end).
  - Laboratory Notebook: 10 Marks
  - Experimental work and data analysis:10 Marks
  - Presentation and Viva voce: 20 Marks

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PHY-CC- 233 : ANALOG SYSTEMS AND APPLICATIONS

Credit: 4 (L- 4:T- 0: P-0) Theory: 60 Lectures

COURSE OBJECTIVES

This course introduces the concept of semiconductor devices and their applications. It also emphasizes on understanding of amplifiers, oscillators, operational amplifier and their applications.

COURSE LEARNING OUTCOME

At the end of the course the student is expected to assimilate the following and possesses basic knowledge of the following.

- N- and P- type semiconductors, mobility, drift velocity, fabrication of P-N junctions; forward and reverse biased junctions.
- Application of PN junction for different type of rectifiers and voltage regulators.
- NPN and PNP transistors and basic configurations namely common base, common emitter and common collector, and also about current and voltage gain.
- Biasing and equivalent circuits, coupled amplifiers and feedback in amplifiers and oscillators.
- Operational amplifiers and knowledge about different configurations namely inverting and non-inverting and applications of operational amplifiers in D to A and A to D conversions.
- To characterize various devices namely PN junction diodes, LEDs, Zener diode, solar cells, PNP and NPN transistors. Also, construct amplifiers and oscillators using discrete components. Demonstrate inverting and non-inverting amplifiers using op-amps.

BROAD CONTENTS OF THE COURSE

- N- and P- type semiconductors.
- Fabrication of p-n junctions; forward and reverse biased junctions.
- Application of p-n junctions.
- Rectifiers and voltage regulators.
- NPN and PNP transistors.
- Common base, common emitter and common collector
- Current and voltage gain.
- Biasing and equivalent circuits.
- Coupled amplifiers and feedback in amplifiers and oscillators.
- Operational amplifiers and its applications in D to A and A to D convertors.

SKILLS TO BE LEARNED

- Learn basic concepts of semiconductor diodes and their applications to rectifiers.
- Learn about junction transistor and their applications.
- Learn about different types of amplifiers including operational amplifierand their applications.
- Learn about sinusoidal oscillators of various types and A/D conversion

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DETAILED CONTENTS OF THE COURSE

MODULE 1

Semiconductor Diodes: Conductivity and Mobility in semiconductor, Concept of Drift velocity. Barrier Formation in PN Junction Diode. Current Flow Mechanism, Static and Dynamic Resistance. Derivation for Barrier Potential, Barrier Width and Current for Step Junction. **(9 Lectures)**

Two-terminal Devices and their Applications: (1) Rectifier Diode: Half-wave, full wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, C-filter, Zener Diode and Voltage Regulation. Principle and structure of (a) LEDs, (b) Photodiode and (c) Solar Cell. **(7 Lectures)**

MODULE 2

Bipolar Junction transistors: n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations. Current gains α and β Relations between α and β. Load Line analysis of Transistors. DC Load line and Q-point. Physical Mechanism of Current Flow. Active, Cutoff and Saturation Regions. **(7 Lectures)**

Amplifiers: Basic transistor amplifier, Transistor Biasing and Stabilization Circuits. Transistor as 2-port Network. h-parameter Equivalent Circuit. Analysis of a single-stage CE amplifier using Hybrid Model. Input and Output Impedance. Current, Voltage and Power Gains. Classification of Class A, B & C Amplifiers. **(10 Lectures)**

MODULE 3

Coupled Amplifier: Two stage RC-coupled amplifier and its frequency response. **(4 Lectures)**

Feedback in Amplifiers: Effects of Positive and Negative Feedback on Input Impedance, Output Impedance, Gain, Stability, Distortion and Noise. **(4 Lectures)**

Sinusoidal Oscillators: Barkhausen's Criterion for self-sustained oscillations. RC Phase shift oscillator, determination of Frequency. Hartley & Colpitts oscillators. **(5 Lectures)**

MODULE 4

Operational Amplifiers (Black Box approach): Characteristics of an Ideal and Practical Op- Amp. Open-loop and Closed-loop Gain. CMRR. Slew Rate, Virtual ground. **(5 Lectures)**

Applications of Op-Amps: (1) Inverting and non-inverting amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator, (5) Integrator, (6) Log amplifiers, (7) Zero crossing detectors. **(9 Lectures)**

TEXT BOOKS

1. Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
2. Electronic Devices & circuits, S.Salivahanan & N.S.Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill.
3. OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall.

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REFERENCE BOOKS

1. Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
2. Solid State Electronic Devices, B.G.Streetman & S.K.Banerjee, 6th Edn.,2009, PHI Learning.
3. Microelectronic circuits, A.S. Sedra, K.C. Smith, A.N. Chandorkar, 2014, 6th Edn., Oxford University Press.
4. Electronic circuits: Handbook of design & applications, U.Tietze, C.Schenk, 2008, Springer.
5. Semiconductor Devices: Physics and Technology, S.M. Sze, 2nd Ed., 2002, Wiley India.
6. Microelectronic Circuits, M.H. Rashid, 2nd Edition, Cengage Learning.
7. Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India.

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PHY-CC-233 (Practical) : PHYSICS LABORATORY - VII

Credit: 2 (L- 0:T- 0: P-2)

Practical: 60 Hours

COURSE OBJECTIVES

The objective of this course is to setup various types of laboratory experiments on analogue electronics and understand some different concept of electronics.

COURSE LEARNING OUTCOME

Through the various experiments in the laboratory a student will learn

- construction and use of specific analogue devices and experimental apparatuses used in the lab, including necessary precautions.
- review of experimental data analysis, sources of error and their estimation in detail, writing of scientific laboratory reports including proper reporting of errors.

SKILLS TO BE LEARNED

- Hand on experience on analogue electronics related phenomena.
- Idea of signal processing application.
- Data analysis, error calculation and laboratory report preparation.

DETAILED CONTENTS OF THE COURSE

1. To study V-I characteristics of PN junction diode, and Light emitting diode.
2. To study the V-I characteristics of a Zener diode and its use as voltage regulator.
3. Study of V-I & power curves of solar cells, and find maximum power point & efficiency.
4. To study the characteristics of a Bipolar Junction Transistor in CE configuration.
5. To study the various biasing configurations of BJT for normal class A operation.
6. To design a CE transistor amplifier of a given gain (mid-gain) using voltage divider bias.
7. To study the frequency response of voltage gain of a RC-coupled transistor amplifier.
8. To design a Wien bridge oscillator for given frequency using a nop-amp.
9. To design a phase shift oscillator of given specifications using BJT.
10. To study the Colpitt`s oscillator.
11. To design a digital to analog converter (DAC) of given specifications.
12. To study the analog to digital convertor (ADC) IC.
13. To design an inverting amplifier using Op-amp (741, 351) for dc voltage of given gain.
14. To design inverting amplifier using Op-amp (741, 351) and study its frequency response.
15. To design non-inverting amplifier using Op-amp (741, 351) & study its frequency response.
16. To study the zero-crossing detector and comparator.
17. To add two dc voltages using Op-amp in inverting and non-inverting mode.
18. To design a precision Differential amplifier of given I/O specification using Op-amp.
19. To investigate the use of an op-amp as an Integrator.

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20. To investigate the use of an op-amp as a Differentiator.
21. To design a circuit to simulate the solution of a $1^{st}/2^{nd}$ order differential equation.

TEXT BOOKS

1. Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.
2. OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4^{th} edition, 2000, Prentice Hall.

REFERENCE BOOKS

1. Electronic Devices & circuit Theory, R.L. Boylestad & L.D. Nashelsky, 2009,
2. Electronic Principle, Albert Malvino, 2008, Tata Mc-Graw Hill.

ASSESSMENT: MARKING SCHEME

Total Marks: 50

- **Internal assessment:** 10 marks
- **End term examination:** 40 (A laboratory examination will be conducted at the semester end).
  - Laboratory Notebook: 10 Marks
  - Experimental work and data analysis:10 Marks
  - Presentation and Viva voce: 20 Marks

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PHY-CC-241 : MATHEMATICAL PHYSICS–III

Credit: 4 (L- 4:T- 0: P-0) Theory: 60 Lectures

COURSE OBJECTIVES

The emphasis of the course is on applications in solving problems of interest to physicists. Students will be examined on the basis of problems, seen and unseen. The course will develop understanding of the basic concepts underlying complex analysis and complex integration and enable student to use Fourier and Laplace Transform to solve real world problems.

COURSE LEARNING OUTCOME

- Learn about the complex numbers and their properties, functions of complex numbers and their properties such as analyticity, poles and residues. The students are expected to learn the residue theorem and its applications in evaluating definite integrals.
- Learn about the Fourier transform, the inverse Fourier transform, their properties and their applications in physical problems. They are also expected to learn the Laplace transform, the inverse Laplace transforms, their properties and their applications in solving physical problems.
- In the laboratory course, the students should apply their C++/Scilab programming language to solve the following problems:
    (i) Solution first- and second- order ordinary differential equations with appropriate boundary conditions.
    (ii) Evaluation of the Gaussian integrals.
    (iii) Evaluation of a converging infinite series up to a desired accuracy.
    (iv) Evaluation of the Fourier coefficients of a given periodic function.
    (v) Plotting the Legendre polynomials and the Bessel functions of different orders and interpretations of the results.
    (vi) Least square fit of a given data to a graph.

BROAD CONTENTS OF THE COURSE

- Complex Analysis
- Integrals Transforms
- Fourier Transforms
- Laplace Transform

SKILLS TO BE LEARNED

- Knowledge of various mathematical tools like complex analysis, integral transform will equip the student with reference to solve a given ODE, PDE.
- These skills will help in understanding the behavior of the modeled system/s.

DETAILED CONTENTS OF THE COURSE

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MODULE 1

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

MODULE 2

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

MODULE 3

Laplace Transforms: Laplace Transform (LT) of Elementary functions. Properties of LTs: Change of Scale Theorem, Shifting Theorem. LTs of 1st and 2nd order Derivatives and Integrals of Functions, Derivatives and Integrals of LTs. LT of Unit Step function, Dirac Delta function, Periodic Functions. Convolution Theorem. Inverse LT. **(15 Lectures)**

MODULE 4

Introduction to probability: Independent random variables: Probability distribution functions; binomial, Gaussian, and Poisson, with examples. Mean and variance. Dependent events: Conditional Probability. Bayes' Theorem and the idea of hypothesis testing. **(8 Lectures)**

Theory of Errors: Systematic and Random Errors. Propagation of Errors. Normal Law of Errors. Standard and Probable Error. Least-squares fit. Error on the slope and intercept of a fitted line. **(7 Lectures)**

TEXT 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. Mathematics for Physicists, P. Dennery and A.Krzywicki, 1967, Dover Publications.
3. Complex Variables, A.S.Fokas & M.J.Ablowitz, 8th Ed., 2011, Cambridge Univ. Press.

REFERENCE BOOKS

4. Complex Variables, A.K. Kapoor, 2014, Cambridge Univ. Press.
5. Complex Variables and Applications, J.W. Brown & R.V. Churchill, 7th Ed. 2003, Tata McGraw-Hill.
6. First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940, Jones & Bartlett.

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PHY-CC-241 (Practical) : PHYSICS LABORATORY - VIII

Credit: 2 (L- 0:T- 0: P-2) Practical: 60 Hours

COURSE OBJECTIVES

The objective of this course is to develop skill to solve analyses different problems discussed Mathematical Physics course though SciLab. In the course, the program list is only suggestive and students should be encouraged to do more problems to get the more idea.

COURSE LEARNING OUTCOME

- How to deploy the computational methods to solve physical problems.

SKILLS TO BE LEARNED

- Computer programming and numerical analysis.
- Solving of various problems of physics using Scilab/C^{++} based simulations.

DETAILED CONTENTS OF THE COURSE

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

1. Solve the differential equations
   a) $\frac{dy}{dx} = e^{-x}$ with $y = 0 \ \ for\ x = 0$
   b) $\frac{dy}{dx} + e^{-x}y = x^2$
   c) $\frac{d^2y}{dx^2} + 2\frac{dy}{dt} = -y$
   d) $\frac{d^2y}{dx^2} + \frac{dy}{dt}e^{-}t = -y$
2. Boundary Value Problems:
   - Solution of Ordinary Differential equation (Boundary Value Problems using finite Difference and shooting methods:
     - Solve $y''(x) + y(x) = 0 \ \ with\ y(0) = 1, \ \ y\left(\frac{\pi}{2}\right) = 1 \ \ for\ 0 < x < \pi$
     - Solve for the steady state concentration profile $y(x)$ in the reaction-diffusion problem given by $y''(x) - y(x) = 0 \ \ with\ y(0) = 1, \ \ y'(1) = 0$
3. Solution to Partial Differential equation: Finite Difference and Crank-Nicholson methods to solve Laplace equation, wave equation, and Heat Equation. Solve differential equations.
4. Frobenious methods and special functions: Gauss Quadrate Integration Method-Gass Legendre, Gauss Lagaurre and Gauss Hermite

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- Verification of Orthogonality of Legendre Polynomials

$$\int_{-1}^{+1} P_n(\mu)P_m(\mu)\ d\mu = \frac{2}{(2n+1)}\delta_{n,m}$$

- Plot $P_n(\mu), j_v(x)$
- Show recursion relation
    - Complex analysis: Integrate

$$\int_{-1}^{+1} \frac{1}{(x^2+2)}dx$$

Numerically using Gauss Lagurre method and check with contour integration

5. Dirac Delta Function: representations of Dirac delta function as a limiting sequence of functions. Verify the properties of Dirac Delta function. e.g. Evaluate

$$\frac{1}{\sqrt{2\pi\sigma^2}}\int \exp\left(-\frac{(x-2)^2}{2\sigma^2}\right)(x+3)\ dx$$

for $\sigma = 1, 0.1, 0.001$ and show that it tens to 5, Use Hermite Gauss quadrature method and also Simpson method with appropriate limits.

6. Fourier Series:
    - Program to sum

$$\sum_{n=1}^{\infty} 0.2^n$$

    - Evaluate the Fourier coefficients of a given periodic function (e.g. square wave, triangle wave, half wave and full wave rectifier etc.)
7. Weighted Least square fitting of given data (x,y) with known error/uncertainty-values using user defined function.
8. Integral transform:
    - Discrete and Fast Fourier Transform of given function in tabulated or mathematical form e.g function $\exp(-x^2)$.
    - Perform circuit analysis of a general LCR circuit using Laplace's transform.
9. Calculation of error for each data point of observations recorded in experiments done in previous semesters (choose any two).
10. Calculation of least square fitting manually without giving weightage to error. Confirmation of least square fitting of data through computer program.

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11. Evaluation of trigonometric functions e.g. *sin ϑ,* Given Bessel's function at N points find its value at an intermediate point. Complex analysis: Integrate $1/(x^2+2)$ numerically and check with computer integration.
12. Compute the n^{th} roots of unity for n = 2, 3, and4.
13. Find the two square roots of $-5+12j$.
14. Integral transform: FFTof a function.
15. Solve Kirchoff's Current law for any node of an arbitrary circuit using Laplace's transform.
16. Solve Kirchoff's Voltage law for any loop of an arbitrary circuit using Laplace's transform.
17. Perform circuit analysis of a general LCR circuit using Laplace's transform.

TEXT BOOKS

1. Scilab by example: M. Affouf, 2012. ISBN:978-1479203444.
2. Scilab (A free software to Matlab): H.Ramchandran, A.S.Nair. 2011, S. Chand & Company.
3. Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering.

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. Mathematics for Physicists, P. Dennery and A. Krzywicki, 1967, Dover Publications.
3. Applications: A. VandeWouwer, P. Saucez, C. V. Fernández., 2014, Springer, ISBN:978-3319067896.
4. A Guide to MATLAB, B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, 2014, 3rdEdn., Cambridge University Press.
5. Scilab Image Processing: Lambert M. Surhone. 2010 Betascript Publishing.
6. https://web.stanford.edu/~boyd/ee102/**laplace**_ckts.pdf.
7. ocw.nthu.edu.tw/ocw/upload/12/244/12handout.pdf.

ASSESSMENT: MARKING SCHEME

Total Marks: 50

- **Internal assessment:** 10 marks
- **End term examination:** 40 marks (laboratory exam. will be conducted at the semester end).
  - Laboratory Notebook: 10 Marks
  - Programming and problem solving : 15 Marks
  - Viva voce: 15 Marks

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PHY-CC-242 : ELEMENTS OF MODERN PHYSICS

Credit: 4 (L- 4:T- 0: P-0) Theory: 60 Lectures

COURSE OBJECTIVES

The objective of this course is to teach the physical and mathematical foundations necessary for learning various topics in modern physics which are crucial for understanding atoms, molecules, photons, nuclei and elementary particles. These concepts are also important to understand phenomena in laser physics, condensed matter physics and astrophysics.

COURSE LEARNING OUTCOME

- Know main aspects of the inadequacies of classical mechanics and understand historical development of quantum mechanics and ability to discuss and interpret experiments that reveal the dual nature of matter.
- Understand the theory of quantum measurements, wave packets and uncertainty principle.
- Understand the central concepts of quantum mechanics: wave functions, momentum and energy operator, the Schrodinger equation, time dependent and time independent cases, probability density and the normalization techniques, skill development on problem solving e.g. one-dimensional rigid box, tunneling through potential barrier, step potential, rectangular barrier.
- Understanding the properties of nuclei like density, size, binding energy, nuclear forces and structure of atomic nucleus, liquid drop model and nuclear shell model and mass formula.
- Ability to calculate the decay rates and lifetime of radioactive decays like alpha, beta, gamma decay. Neutrinos and its properties and role in theory of beta decay.
- Understand fission and fusion well as nuclear processes to produce nuclear energy in nuclear reactor and stellar energy in stars.
- Understand various interactions of electromagnetic radiation with matter. Electron positron pair creation.
- Understand the spontaneous and stimulated emission of radiation, optical pumping and population inversion. Three level and four level lasers. Ruby laser and He-Ne laser in details. Basic lasing.
- In the laboratory course, the students will get opportunity to perform the following experiments
- Measurement of Planck's constant by more than one method.
- Verification of the photoelectric effect and determination of the work Function of a metal.
- Determination of the charge of electron and e/m of electron.
- Determination of the ionization potential of atoms.
- Determine the wavelength of the emission lines in the spectrum of Hydrogen atom.
- Determine the absorption lines in the rotational spectrum of molecules.
- Determine the wavelength of Laser sources by single and Double slit experiments
- Determine the wavelength and angular spread of He-Ne Laser using plane diffraction grating.

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- Verification of the law of the Radioactive decay and determine the mean life time of a Radioactive Source, Study the absorption of the electrons from Beta decay. Study of the electron spectrum in Radioactive Beta decays of nuclei.
- Plan and Execute 2-3 group projects in the field of Atomic, Molecular and Nuclear Physics in collaboration with other institutions, if, possible where advanced facilities are available.

BROAD CONTENTS OF THE COURSE

- One dimensional potential problem of bound states and scattering.
- Elementary introduction of nuclear physics with emphasis on
    a) Nuclear Structure
    b) Nuclear Forces
    c) Nuclear Decays
    d) Fission and Fusion
- Introduction to Lasers

SKILLS TO BE LEARNED

- Comprehend the failure of classical physics and need for quantum physics.
- Grasp the basic foundation of various experiments establishing the quantum physics by doing the experiments in laboratory and interpreting them.
- Formulate the basic theoretical problems in one, two- and three-dimensional physics and solve them.
- Learning to apply the basic skills developed in quantum physics to various problems in Nuclear Physics, Atomic Physics and Laser Physics.
- Learn to apply basic quantum physics to Ruby Laser, He-Ne Laser.

DETAILED CONTENTS OF THE COURSE

MODULE 1

Planck's quantum, Planck's constant and light as a collection of photons; Blackbody Radiation: Quantum theory of Light; Photo-electric effect and Compton scattering. De Broglie wavelength and matter waves; Davisson-Germer experiment. Wave description of particles by wave packets. Group and Phase velocities and relation between them. Two-Slit experiment with electrons. Probability. Wave amplitude and wave functions. **(15 Lectures)**

MODULE 2

Position measurement- gamma ray microscope thought experiment; Wave-particle duality, Heisenberg uncertainty principle, Derivation from Wave Packets impossibility of a particle following a trajectory;

(3 Lectures)

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Two slit interference experiment with photons, atoms and particles; linear superposition principle as a consequence; Matter waves and wave amplitude; Schrodinger equation; Momentum and Energy operators; stationary states; physical interpretation of a wave function, Physical Acceptability of Wave Functions , normalization; Probability and probability current densities in one dimension. **(12 Lectures)**

MODULE 3

Size and structure of nucleus, nuclear forces, N-Z graph, Liquid Drop model: semi-empirical mass formula and binding energy curve, Nuclear Shell Model and magic numbers. **(7 Lectures)**

Radioactivity, stability of the nucleus; Law of radioactive decay; Mean life and half-life; Alpha decay; Beta decay- energy spectrum and neutrino hypothesis; Gamma ray emission, energy-momentum conservation: electron-positron pair creation by gamma photons **(8 Lectures)**

MODULE 4

Fission and fusion: Generation of energy in Fission and fusion; Nuclear reactor: slow neutrons interacting with Uranium 235; Fusion stellar energy (brief qualitative discussions). **(3 Lectures)**

Particle Accelerates and Detectors: Linear accelerator, Cyclotron, Synchrotrons. Gas detectors: ionization chamber and GM Counter. Basic principle of Scintillation Detectors and construction of photo-multiplier tube (PMT). **(8 Lectures)**

Lasers: Einstein's coefficients. Optical Pumping and Population Inversion. Three-Level and Four-Level Lasers. Ruby Laser and He-Ne Laser. Basic lasing. **(4 Lectures)**

TEXT BOOKS

1. Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
2. Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGraw-Hill.
3. Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.

REFERENCE BOOKS

4. Physics for scientists and Engineers with Modern Physics, Jewett and Serway, 2010, Cengage Learning.
5. Modern Physics, G.Kaur and G.R. Pickrell, 2014, McGraw Hill.
6. Quantum Mechanics: Theory & Applications, A.K.Ghatak & S.Lokanathan, 2004, Macmillan.

Additional Books for Reference

7. Modern Physics, J.R. Taylor, C.D. Zafiratos, M.A. Dubson, 2004, PHI Learning.
8. Theory and Problems of Modern Physics, Schaum`s outline, R. Gautreau and W. Savin, 2nd Edn, Tata McGraw-Hill Publishing Co. Ltd.
9. Quantum Physics, Berkeley Physics, Vol.4. E.H.Wichman, 1971, Tata McGraw-Hill Co.
10. Six Ideas that Shaped Physics: Particle Behave like Waves, T.A.Moore, 2003, McGraw Hill.
11. Quantum Mechanics, R. Eisberg and R. Resnick, John Wiley & Sons.

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PHY-CC-242 (Practical) : PHYSICS LABORATORY - IX

Credit: 2 (L- 0:T- 0: P-2)

Practical: 60 Hours

COURSE OBJECTIVES

Demonstration and practical laboratory experiments on modern physics.

COURSE LEARNING OUTCOME

- use of specific measurement instruments and experimental apparatuses used in the modern physics lab, including necessary precautions.
- review of experimental data analysis, sources of error and their estimation in detail, writing of scientific laboratory reports including proper reporting of errors.

SKILLS TO BE LEARNED

- Hand on experience on modern physics related phenomena.
- Experience for the arrangement of experimental set-up of opto-electronic experiment.

DETAILED CONTENTS OF THE COURSE

1. Measurement of Planck's constant using black body radiation and photo-detector.
2. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light.
3. To determine work function of material of filament of directly heated vacuum diode.
4. To determine the Planck's constant using LEDs of at least 4 different colours.
5. To determine the wavelength of H-alpha emission line of Hydrogen atom.
6. To determine the ionization potential of mercury.
7. To determine the absorption lines in the rotational spectrum of Iodine vapour.
8. To determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet.
9. To setup the Millikan oil drop apparatus and determine the charge of an electron.
10. To show the tunneling effect in tunnel diode using I-V characteristics.
11. To determine the wavelength of laser source using diffraction of single slit.
12. To determine the wavelength of laser source using diffraction of double slits.
13. To determine (1) wavelength and (2) angular spread of He-Ne laser using plane diffraction grating.

TEXT BOOKS

1. A Text Book of Practical Physics, I. Prakash& Ramakrishna, 11th Edn, 2011, Kitab Mahal.

REFERENCE BOOKS

2. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House

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3. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.

ASSESSMENT: MARKING SCHEME

Total Marks: 50

- **Internal assessment:** 10 marks
- **End term examination:** 40 marks (laboratory exam. will be conducted at the semester end).
  - Laboratory Notebook: 10 Marks
  - Experimental work and data analysis:10 Marks
  - Presentation and Viva voce: 20 Marks

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PHY-CC-243 : DIGITAL SYSTEMS AND APPLICATIONS

Credit: 4 (L- 4:T- 0: P-0) Theory: 60 Lectures

COURSE OBJECTIVES

This is one of the core paper in physics curriculum, which introduces the concept of Boolean algebra and the basic digital electronics. In this course, students will be able to understand the working principle of CRO, Data processing circuits, Arithmetic Circuits, sequential circuits like registers, counters etc. based on flip-flops. In addition, students will get an overview of microprocessor architecture and programming.

COURSE LEARNING OUTCOME

As the successful completion of the course, the student is expected to be conversant with the following:

- Basic working of an oscilloscope including its different components and to employ the same to study different wave forms and to measure voltage, current, frequency and phase.
- Secure first-hand idea of different components including both active and passive components to gain an insight into circuits using discrete components and also to learn about integrated circuits.
- About analog systems and digital systems and their differences, fundamental logic gates, combinational as well as sequential and number systems.
- Synthesis of Boolean functions, simplification and construction of digital circuits by employing Boolean algebra.
- Sequential systems by choosing Flip-Flop as a building bock- construct multivibrators, counters to provide a basic idea about memory including RAM, ROM and also about memory organization.
- Microprocessor and assembly language programming with Intel µP 8085.
- In the laboratory he is expected to construct both combinational circuits and sequential circuits by employing NAND as building blocks and demonstrate Adders, Subtractors, Shift Registers, and multivibrators using 555 ICs.

BROAD CONTENTS OF THE COURSE

- Digital storage oscilloscope.
- Active and passive filters.
- Fundamental logic gates, combinational as well as sequential and number systems.
- Synthesis of Boolean functions, simplification and construction of digital circuits by employing Boolean algebra.
- Sequential systems by choosing Flip Flop as a building bock- construct multivibrators, counters to provide a basic idea about RAM, ROM and also about memory organization.

SKILLS TO BE LEARNED

- Acquire skills to understanding the functioning and operation of CRO to measure physical quantities in electrical and electronic circuits.

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- Learn the basics of IC and digital circuits, and difference between analog and digital circuits. Various logic GATES and their realization using diodes and transmitters.
- Learn fundamental of Boolean algebra and their role in constructing digital circuits.
- Learn about combinatorial and sequential systems by building block circuits to construct multivibrators and counters.
- Understand basics of microprocessor and assembly language programming with examples.

DETAILED CONTENTS OF THE COURSE

MODULE 1

Introduction to CRO: Block Diagram of CRO. Electron Gun, Deflection System and Time Base. Deflection Sensitivity. Applications of CRO: (1) Study of Waveform, (2) Measurement of Voltage, Current, Frequency, and Phase Difference. **(5 Lectures)**

Integrated Circuits (Qualitative treatment only): Discrete components. Wafer. Chip. Advantages and drawbacks of ICs. Scale of integration: SSI, MSI, LSI and VLSI (basic idea). Classification of ICs. Examples of Linear and Digital lCs. **(6 Lectures)**

Number systems: Binary Numbers. BCD, Octal and Hexadecimal numbers, conversion form one number system to another. **(4 Lectures)**

MODULE 2

Logic Gates: AND, OR and NOT Gates (realization using Diodes and Transistor). NAND and NOR Gates as Universal Gates. XOR and XNOR Gates and application as Parity Checkers. **(5 Lectures)**

Boolean algebra: De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Algebra. Minterms and Maxterms. Conversion of a Truth table into Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map. **(6 Lectures)**

Data processing circuits: Multiplexers, De-multiplexers, Decoders, Encoders. **(4 Lectures)**

MODULE 3

Arithmetic Circuits: Adders and Subtractors, 4-bit binary Adder/Subtractor. **(5 Lectures)**

Sequential Circuits: SR, D, and JK Flip-Flops. Clocked (Level and Edge Triggered) Flip- Flops. Preset and Clear operations. JK Flip-Flop and M/S JK Flip-Flop. **(6 Lectures)**

Timers: IC 555: block diagram and applications: multivibrators using IC 555. **(4 Lectures)**

MODULE 4

Registers and counters: Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel- in-Parallel-out Shift Registers (only up to 4 bits). Counters, Ring Counter. Asynchronous counters, Synchronous Counter. **(6 Lectures)**

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Computer Organization: Input/output Devices. Data storage (idea of RAM and ROM). Computer memory. Memory organization & addressing. Memory Map. **(5 Lectures)**

Microprocessor (Fundamental idea only): Microprocessor Architecture: 8085 Microprocessor. Block diagram and working, assembly language (basics idea only) **(4 Lectures)**

TEXT BOOKS

1. Fundamentals of Digital Circuits, Anand Kumar, 2nd Edn, 2009, PHI Learning Pvt. Ltd.
2. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.

REFERENCE BOOKS

3. Digital Principles and Applications, A.P. Malvino, D.P.Leach and Saha, 7th Ed., 2011, Tata McGraw Hill.
4. Digital Electronics G K Kharate , 2010, Oxford University Press.
5. Digital Systems: Principles & Applications, R.J.Tocci, N.S.Widmer, 2001, PHI Learning.
6. Logic circuit design, Shimon P. Vingron, 2012, Springer.
7. Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
8. Digital Electronics, S.K. Mandal, 2010, 1st edition, McGraw Hill.
9. Microprocessor Architecture Programming & applications with 8085, 2002, R.S. Goankar, Prentice Hall.

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PHY-CC-243 (Practical) : PHYSICS LABORATORY - X

Credit: 2 (L- 0:T- 0: P-2)

Practical: 60 Hours

COURSE OBJECTIVES

The objective of the course to understand digital electronics practically and to get an idea to develop digital circuit design for various purpose.

COURSE LEARNING OUTCOME

- Understand construction and use of CRO, and other experimental apparatuses used in the lab, including necessary precautions.
- Learn about the basic component of digital electronics and to circuit design.

SKILLS TO BE LEARNED

- Hand on experience on Digital electronics.
- Idea of function of common electronic devices different digital ICs.
- Design and development of digital circuits.
- Use of different types of digital ICs.

DETAILED CONTENTS OF THE COURSE

1. To measure (a) Voltage, and (b) Time period of a periodic waveform using CRO.
2. To test a Diode and Transistor using a Multimeter.
3. To design a switch (NOT gate) using a transistor.
4. To verify and design AND, OR, NOT and XOR gates using NAND gates.
5. To design a combinational logic system for a specified Truth Table.
6. To convert a Boolean expression into logic circuit and design it using logic gate ICs.
7. To minimize a given logic circuit.
8. Half Adder, Full Adder and 4-bit binary Adder.
9. Half Subtractor, Full Subtractor, Adder-Subtractor using Full Adder IC.
10. To build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates.
11. To build JK Master-slave flip-flop using Flip-Flop ICs.
12. To build a 4-bit Counter using D-type/JK Flip-Flop ICs and study timing diagram.
13. To make a 4-bit Shift Register (serial and parallel) using D-type/JK Flip-Flop ICs.
14. To design an astable multivibrator of given specifications using 555Timer.
15. To design a monostable multivibrat or of given specifications using 555Timer.
16. Write the following programs using 8085Microprocessor.
17. Addition and subtraction of numbers using direct addressing mode.
18. Addition and subtraction of numbers using indirect addressing mode.
19. Multiplication by repeated addition.
20. Division by repeated subtraction.

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TEXT BOOKS

1. Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.

REFERENCE BOOKS

1. Modern Digital Electronics, R.P. Jain, 4th Edition, 2010, Tata McGraw Hill.
2. Microprocessor Architecture Programming and applications with 8085, R.S. Goankar, 2002, Prentice Hall.
3. Microprocessor 8085: Architecture, Programming and interfacing, A. Wadhwa, 2010, PHI Learning.

ASSESSMENT: MARKING SCHEME

Total Marks: 50

- **Internal assessment:** 10 marks
- **End term examination:** 40 marks (laboratory exam. will be conducted at the semester end).
  - Laboratory Notebook: 10 Marks
  - Experimental work and data analysis:10 Marks
  - Presentation and Viva voce: 20 Marks

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PHY-CC-351 : QUANTUM MECHANICS AND APPLICATIONS

Credit: 4 (L- 4:T- 0: P-0) Theory: 60 Lectures

COURSE OBJECTIVES

After learning the elements of modern physics, in this course students would be exposed tomore advanced concepts in quantum physics and their applications to problems of the subatomic world.

COURSE LEARNING OUTCOME

- Revision of this course will enable the student to get familiar with quantum mechanics formulation.
- After an exposition of inadequacies of classical mechanics in explaining microscopic phenomena, quantum theory formulation will be introduced through Schrodinger equation.
- The interpretation of wave function of quantum particle and probabilistic nature of its location and subtler points of quantum phenomena will be exposed to the student.
- Through understanding the behavior of quantum particle encountering a potential barrier, the student will get exposed to solving non-relativistic hydrogen atom, for its spectrum and eigenfunctions.
- Study of influence of electric and magnetic fields on atoms will help in understanding Stark effect and Zeeman Effect respectively.
- The experiments using Sci-lab will enable the student to appreciate nuances involved in the theory.
- This basic course will form a firm basis to understand quantum many body problems.
- In the laboratory course, with the exposure in computational programming in the computer lab, the student will be in a position to solve Schrodinger equation for ground state energy and wave functions of various simple quantum mechanical one- dimensional and three-dimensional potentials.

BROAD CONTENTS OF THE COURSE

- Time dependent Schrodinger equation
- Time independent Schrodinger equation
- General discussion of bound states in an arbitrary potential
- Quantum Theory of hydrogen-like atoms
- Atoms in Electric and Magnetic Fields
- Atoms in External Magnetic Fields
- Many electron atoms

SKILLS TO BE LEARNED

- This course shall develop an understanding of how to model a given problem such as particle in a box, hydrogen atom, hydrogen atom in electric fields.

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- Understanding of many electron atoms, L-S and J-J couplings.
- Understanding the different Quantum Systems in atomic and nuclear physics.

DETAILED CONTENTS OF THE COURSE

MODULE 1

Time dependent Schrodinger equation: Time dependent Schrodinger equation. Superposition Principles. Eigenvalues and Eigenfunctions. Position, momentum and Energy operators; commutator of operators; Expectation values of position and momentum. Wave Function of a Free Particle. **(7 Lectures)**

Time independent Schrodinger equation: stationary states and energy eigenvalues; expansion of an arbitrary wavefunction as a linear combination of energy eigenfunctions; General solution of the time dependent Schrodinger equation; Application to spread of Gaussian wave-packet for a free particle in one dimension; Fourier transforms and momentum space wavefunction; **(8 Lectures)**

MODULE 2

General discussion of bound states in an arbitrary potential- continuity of wavefunction, boundary condition and emergence of discrete energy levels in One dimensional infinitely rigid box and one-dimensional problem-square well potential; Quantum mechanical scattering and tunneling in across a step potential & rectangular potential barrier. Quantum mechanics of simple harmonic oscillator-energy levels and energy eigenfunctions using Frobenius method; Hermite polynomials; ground state, zero-point energy & uncertainty principle. **(8 Lectures)**

Quantum theory of hydrogen-like atoms: Radial wavefunctions from Frobenius method; shapes of the probability densities for ground & first excited states; quantum numbers **(5 Lectures)**

MODULE 3

Atomic Structure: Review on atomic models, Bohr's Model – energy level diagram, drawbacks, Sommerfeld Theory, vector atom model **(5 Lectures)**

Atoms in Electric & Magnetic Fields: Orbital angular momentum and spin angular momentum Space quantization. Larmor's Theorem. Spin Magnetic Moment. Stern- Gerlach Experiment Electron Magnetic Moment and Magnetic Energy, Gyromagnetic Ratio and Bohr Magneton. **(10 Lectures)**

MODULE 4

Atoms in External Magnetic Fields: - Normal and Anomalous Zeeman Effect (quantum mechanical treatment) . Paschen Back and Stark Effect (Qualitative Discussion only). **(5 Lectures)**

Many electron atoms: Pauli's Exclusion Principle. Symmetric & Antisymmetric Wave Functions. Periodic table. Fine structure. Spin orbit coupling. Spectral Notations for Atomic States. Total angular momentum. Vector Model. Spin-orbit coupling in atoms-L-S and J- J couplings. Hund's Rule. Term symbols. Spectra of Hydrogen and Alkali Atoms (Na etc.). **(10 Lectures)**

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TEXT BOOKS

1. Quantum Mechanics, Leonard I. Schiff, 3rd Edn. 2010, Tata McGraw Hill.
2. Introduction to Quantum Mechanics, D.J. Griffith, 2nd Ed. 2005, Pearson Education
3. Quantum Mechanics, G. Aruldhas, 2nd Edn. 2002, PHI Learning of India.

REFERENCE BOOKS

4. A Text book of Quantum Mechanics, P.M.Mathews and K.Venkatesan, 2nd Ed., 2010, McGraw Hill
5. Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn., 2002, Wiley.
6. Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning.
7. Quantum Mechanics: Foundations & Applications, Arno Bohm, 3rd Edn., 1993, Springer
8. Quantum Mechanics for Scientists & Engineers, D.A.B. Miller, 2008, Cambridge University Press
9. Quantum Mechanics, Eugen Merzbacher, 2004, John Wiley and Sons, Inc.
10. Quantum Mechanics, Walter Greiner, 4th Edn., 2001, Springer

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PHY-CC-351 (Practical) : PHYSICS LABORATORY - XI

Credit: 2 (L- 0:T- 0: P-2)

Practical: 60 Hours

COURSE OBJECTIVES

In this laboratory course, the experiments using Sci-lab will enable the student to appreciate nuances involved in thetheory of quantum mechanics.

COURSE LEARNING OUTCOME

- Better understanding of various concepts of quantum mechanics
- Solving problems related to quantum mechanics using Scilab

SKILLS TO BE LEARNED

- Scilab/C^{++} based simulations of various phenomenon in quantum mechanics

DETAILED CONTENTS OF THE COURSE

Use C/C++/Scilab for solving the following problems based on Quantum Mechanics like

1. Solve the s-wave Schrodinger equation for the ground state and the first excited state of the hydrogenatom
   a. $\frac{d^2y}{dt^2} = A(r), u(r), \quad A(r) = \frac{2m}{\hbar^2}[V(r) - E] \quad$ where $V(r) = -\frac{e^2}{r}$Where $m \rightarrow$ is the reduced mass of the electron
   b. Obtain the energy eigenvalues and plot the corresponding wavefunctions. Remember that the ground state energy of the hydrogen atom is ≈ 13.6 eV. Take $e = 3.795\ (eVÅ)^{1/2}$, $\hbar c = 1973\ (eVÅ)$ and $m = 0.511 \times 10^6\ eV/c^2$
2. Solve the s-wave radial Schrodinger equation for an atom:
   a. $\frac{d^2y}{dt^2} = A(r), u(r), \quad A(r) = \frac{2m}{\hbar^2}[V(r) - E]$
   b. Where, m is the reduced mass of the system (which can be chosen to be the mass of an electron), for the screened coulomb potential
   c. $V(r) = -\frac{e^2}{r}e^{-\frac{r}{a}}$
   d. Find the energy (ineV)of the ground state of the atom to an accuracy of three significant digits. Also, plot thecorrespondingwavefunction. Take $m = 0.511 \times 10^6\ eV/c^2$, $e = 3.795\ (eVÅ)$ and $a = 3Å$, $5Å$, $7Å$. In these units $\hbar c = 1973\ (eVÅ)$. The ground state energy is expected to be above -12 eV in all three cases.

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3. Solve the $s-$ wave radial Schrodinger equation for a particle of mass m

   a. $\frac{d^2y}{dt^2} = A(r), u(r), \quad A(r) = \frac{2m}{\hbar^2}[V(r) - E]$

      i. For a harmonic oscillator potential

   b. $V(r) = \frac{1}{2}kr^2 + \frac{1}{3}br^3$

   c. For the ground state energy $(inMeV)$ of particle to an accuracy of three significant digits. Also, plot the corresponding wave function. Choose $m = 940\ MeV/c^2$, $k = 100\ MeVfm^{-2}, b = 0,\ 10,\ 30\ MeVfm^{-3}$. In these units $c\hbar = 197.3\ MeVfm$. The ground state energy is accepted to lie between 90 and $110\ MeV$ for all three cases.

4. Solve the $s-$ wave radial Schrodinger equation for the vibrations of hydrogen molecule

   a. $\frac{d^2y}{dt^2} = A(r), u(r), \quad A(r) = \frac{2\mu}{\hbar^2}[V(r) - E]$

      i. Where, $\mu \rightarrow$ reduced mass of the two atom system for Morse potential

   b. $V(r) = D\left(e^{-2ar'} - e^{-ar'}\right),\ r' = \frac{r-r_0}{r}$

   c. Find the lowest vibrational energy $(inMeV)$ of the molecule to an accuracy of three significant digits. Also plot the correspond wave function.

   d. Take: $\mathrm{m} = 940\ \mathrm{MeV/c^2}$, $\mathrm{D} = 0.755501\ \mathrm{eV}$, $\alpha = 1.44$. $\mathrm{r_0} = 0.13349$

TEXT BOOKS

1. An introduction to computational Physics, T.Pang, 2nd Edn.,2006, Cambridge Univ.Press
2. Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific & Engineering Applications: A. VandeWouwer, P. Saucez, C. V. Fernández.2014Springer.
3. Scilab (A Free Software to Matlab): H. Ramchandran, A.S. Nair. 2011 S. Chand &Co.

REFERENCE BOOKS

1. Schaum's outline of Programming with C++. J.Hubbard, 2000,McGraw-HillPublication
2. Numerical Recipes in C: The Art of Scientific Computing, W.H. Pressetal., 3rdEdn.,,Camb. UniversityPress.
3. A Guide to MATLAB, B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, 2014, 3rdEdn., Cambridge UniversityPress
4. Scilab Image Processing: L.M.Surhone.2010 Betascript Publishing

ASSESSMENT: MARKING SCHEME

Total Marks: 50

- **Internal assessment:** 10 marks
- **End term examination:** 40 marks (laboratory exam. will be conducted at the semester end).
  - Laboratory Notebook: 10 Marks
  - Programming and problem solving : 15 Marks
  - Viva voce: 15 Marks

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PHY-CC-352 : SOLID STATE PHYSICS

Credit: 4 (L- 4:T- 0: P-0) Theory: 60 Lectures

COURSE OBJECTIVES

This course introduces the basic concepts and principles required to understand the various properties exhibited by condensed matter, especially solids. It enables the students to appreciate how the interesting and wonderful properties exhibited by matter depend upon its atomic and molecular constituents. The gained knowledge helps to solve problems in solid state physics using relevant mathematical tools. It also communicates the importance of solid-state physics in modern society.

COURSE LEARNING OUTCOME

At the end of the course the student is expected to learn and assimilate the following.

- A brief idea about crystalline and amorphous substances, lattice, unit cell, miller indices, reciprocal lattice, concept of Brillouin zones and diffraction of X-rays by crystalline materials.
- Knowledge of lattice vibrations, phonons and in depth of understanding of Einstein and Debye theory of specific heat of solids.
- Knowledge of different types of magnetism varying from diamagnetism to ferromagnetism and hysteresis loops and energy loss.
- An understanding about the dielectric and ferroelectric properties of materials.
- Understanding the band theory of solids and to differentiate insulators, conductors and semiconductors.
- Understanding the basic idea about superconductors and their classifications.
- To carry out experiments based on the theory that they have learned to measure various material properties in the laboratory

BROAD CONTENTS OF THE COURSE

- Crystalline and amorphous substances, lattice, unit cell, miller indices, reciprocal lattice. Brillouin zones and diffraction of X-rays by crystalline materials.
- Lattice vibrations and phonons
- Different types of magnetism
- Dielectric and ferroelectric materials.
- Band theory of solids
- Insulators, conductors and semiconductors.
- Superconductors and their classifications.

SKILLS TO BE LEARNED

- Basics of crystal structure and physics of lattice dynamics
- The physics of different types of material like magnetic, dielectric, metals and their properties.

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- The physics of insulators, semiconductor and conductors with special emphasis on the elementary band theory of semiconductors.
- The basic theory of superconductors. Type I and II superconductors, their properties and physical concept of BCS theory

DETAILED CONTENTS OF THE COURSE

MODULE 1

Crystal Structure: Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice and Basis. Unit Cell, Bravais lattices, Types of Lattices-close packed structures, packing fraction, Miller Indices. **Reciprocal Lattice.** Brillouin Zones. X-ray, electron and neutron diffraction in crystal, Bragg's Law. Atomic and Geometrical Factor. **(15 Lectures)**

MODULE 2

Elementary Lattice Dynamics: Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains. Acoustical and Optical Phonons. **(6 Lectures)**

Specific heat in solids: Einstein and Debye theories of specific heat. **(4 Lectures)**

Magnetic Properties of Materials. Langevin Theory of diamagnetism, Paramagnetic Domains. Quantum Mechanical Treatment of Paramagnetism. Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Hysteresis and Energy Loss. **(8 Lectures)**

MODULE 3

Dielectric Properties of Materials: Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius Mosotti Equation. Classical Theory of Electric Polarizability. Normal and Anomalous Dispersion. Cauchy and Sellmeir relations. Langevin-Debye equation. Complex Dielectric Constant. **(8 Lectures)**

Ferroelectric Properties of Materials: Structural phase transition, Classification of crystals, Piezoelectric effect, Pyroelectric effect, Ferroelectric effect, Electrostrictive effect, Curie-Weiss Law, Ferroelectric domains, PE hysteresis loop. **(6 lectures)**

MODULE 4

Elementary band theory: Kronig Penny model. Band Gap. Conductor, Semiconductor (P and N type) and insulator. Conductivity of Semiconductor, mobility, Hall Effect. Measurement of conductivity (04 probe method) & Hall coefficient. **(10 Lectures)**

Superconductivity: Experimental Results. Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors, London's Equation and Penetration Depth. Isotope effect. Idea of BCS theory (No derivation) **(6 Lectures)**

TEXT BOOKS

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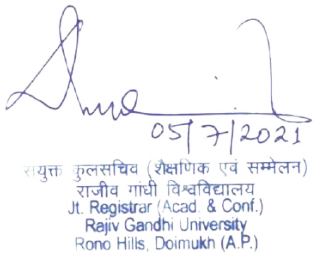
1. Introduction to Solid State Physics, Charles Kittel, 8th Edition, 2004, Wiley India Pvt. Ltd.
2. Elements of Solid State Physics, J.P. Srivastava, 4th Edition, 2015, Prentice-Hall of India
3. Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill

REFERENCE BOOKS

4. Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning
5. Solid-state Physics, H. Ibach and H. Luth, 2009, Springer
6. Solid State Physics, Rita John, 2014, McGraw Hill
7. Elementary Solid State Physics, 1/e M. Ali Omar, 1999, Pearson India
8. Solid State Physics, M.A. Wahab, 2011, Narosa Publications



PHY-CC-352 (Practical) : PHYSICS LABORATORY - XII

Credit: 2 (L- 0:T- 0: P-2)

Practical: 60 Hours

COURSE OBJECTIVES

This laboratory component aims to explain various properties exhibited by solid and to determine some of the parameter of material experimentally. It enables the students to appreciate how the interesting and wonderful properties exhibited by matter depend upon its atomic and molecular constituents. The gained knowledge helps to solve problems in solid state physics using relevant mathematical tools.

COURSE LEARNING OUTCOME

- Learning of the measurement of the magnetic susceptibility, dielectric constant, trace hysteresis loop. They will also employ four probe methods to measure electrical conductivity and the hall set up to determine the hall coefficient of a semiconductor.
- Operation of measuring instruments and experimental apparatuses used in the solid-state physics lab, including necessary precautions.

SKILLS TO BE LEARNED

- To determine various parameters of solids

DETAILED CONTENTS OF THE COURSE

1. To measure susceptibility of paramagnetic solution (Quinck`s Tube Method)
2. To measure the Magnetic susceptibility of Solids.
3. To determine the Coupling Coefficient of a Piezoelectric crystal.
4. To measure the Dielectric Constant of a dielectric Materials with frequency
5. To determine the complex dielectric constant and plasma frequency of metal using Surface Plasmon resonance (SPR)
6. To determine the refractive index of a dielectric layer using SPR
7. To study the PE Hysteresis loop of a Ferroelectric Crystal.
8. To draw the BH curve of Fe using Solenoid & determine energy loss from Hysteresis.
9. To measure the resistivity of a semiconductor (Ge) with temperature by four-probe method (room temperature to 150 oC) and to determine its band gap.
10. To determine the Hall coefficient of a semiconductor sample.
11. Study of Electron spin resonance- determine magnetic field as a function of the resonance frequency
12. Study of Zeeman effect: with external magnetic field; Hyperfine splitting
13. To show the tunneling effect in tunnel diode using I-V characteristics.
14. Quantum efficiency of CCDs

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Rono Hills, Doimukh (A.P.)

TEXT BOOKS

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.

REFERENCE BOOKS

2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
3. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
4. Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India.

ASSESSMENT: MARKING SCHEME

Total Marks: 50

- **Internal assessment:** 10 marks
- **End term examination:** 40 marks (laboratory exam. will be conducted at the semester end).
  - Laboratory Notebook: 10 Marks
  - Experimental work and data analysis:10 Marks
  - Presentation and Viva voce: 20 Marks

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PHY-DE-353 : CLASSICAL MECAHNICS

Credit: 6 (L- 5:T- 1: P-0) Theory: 60 Lectures

COURSE OBJECTIVES

The emphasis of the course is on the ability in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen. This course on classical mechanics trains the student in problem solving ability anddevelops understanding of physical problems. The emphasis of this course is to enhance the understanding of Classical Mechanics (Lagrangian and Hamiltonian Approach).

COURSE LEARNING OUTCOME

- Revision of the knowledge of the Newtonian, the Lagrangian and the Hamiltonian formulations of classical mechanics and their applications in appropriate physical problems.
- Learning about the small oscillation related problems.
- Recapitulating and learning of the special theory of relativity- postulates of the special theory of relativity, Lorentz transformations on space-time and other four vectors, four-vector notations, space-time invariant length, length contraction, time dilation, mass-energy relation, Doppler effect, light cone and its significance, problems involving energy- momentum conservations.
- Learning of the basics of fluid dynamics, streamline and turbulent flow, Reynolds's number, coefficient of viscosity and Poiseuille's equation.
- Review of the retarded potentials, potentials due to a moving charge, Lienard Wiechert potentials, electric and magnetic fields due to a moving charge, power radiated, Larmor's formula and its relativistic generalization.

BROAD CONTENTS OF THE COURSE

- Classical mechanics of point particles.
- Lagrangian and Hamiltonians of simple systems and derivations of equation of motion.
- Small amplitude oscillations
- Special theory of relativity
- Relativistic kinematics of one and two particle system.
- Basics of fluid dynamics

SKILLS TO BE LEARNED

- To define generalised coordinates, generalised velocities, generalised force and write Lagrangian for mechanical system in terms of generalised coordinates.
- To derive Euler-Lagrange equation of motion and solving them for simple mechanical systems.
- To write Hamiltonian for mechanical systems and derive and solving Hamilton's equation of motion for simple mechanical systems.
- Formulate the problem of small amplitude oscillation and solving them to obtain normal modes of oscillation and their frequencies in simple mechanical systems.

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- Development of the basic concepts of special theory of relativity and its applications to dynamical systems of particles.
- Development of the methods of relativistic kinematics of one and two particle system and its application to two particle decay and scattering.
- Development and understanding of the basic concepts of fluid dynamics and its applications to simple problems in liquid flow.

DETAILED CONTENTS OF THE COURSE

MODULE 1

Lagrangian Dynamics and Hamiltonian formulation: Generalized coordinates, Constraints, Principal of Virtual Work, D'Alembert's principal and its applications, Lagrange's equation and its applications. Jacobi integral and energy conservation, Concept of symmetry, velocity dependent potential. Variational calculus and Least Acton principle, Hamilton's principle, Lagrange's equation from Hamilton's principle, Legendre transformations, Hamilton's function and Hamilton's equation, configuration space, phase space and state space, Hamilton's equations from Variational principle **. (15 Lectures)**

MODULE 2

Canonical transformations and Hamilton Jacobi theory: Generating function, canonical transformation and its examples, group property, Lagrange and Poisson brackets and other canonical invariants, equation of motions, Infinitesimal canonical theorem in Poisson bracket formalism, Jacobi identity, Angular momentum Poisson bracket relations. The Hamilton-Jacobi equation for Hamilton's principal and characteristic functions with example; the harmonic oscillator, Separation of variable in Hamilton-Jacobi equation; Acton-angle variables and its examples – the Kepler problem in Acton-angle variables. **(15 Lectures)**

MODULE 3

Small Amplitude Oscillations: Lagrange's equations of motion for small oscillations, eigen value equation and normal coordinates and frequencies for systems with many degrees of freedom, problems for small oscillations-parallel, double, linear triatomic molecule and vibration strings. Minima of potential energy and points of stable equilibrium, Linear and nonlinear waves, Solitary Waves, KdV equation, Solitons. **(15 Lectures)**

MODULE 4

Theory of Relativity-1: Postulates of Special Theory of Relativity. Lorentz Transformations. Minkowski space. The invariant interval, light cone and world lines. Space- time diagrams. Time -dilation, length contraction and twin paradox. Four-vectors: space-like, time-like and light-like. Four-velocity and acceleration. Metric and alternating tensors.Four- momentum and energy-momentum relation. **(15 Lectures)**

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MODULE 5

Theory of Relativity - 2: Doppler effect from a four-vector perspective. Concept of four-force. Conservation of four-momentum. Relativistic kinematics. Application to two-body decay of an unstable particle. **(5 Lectures)**

Fluid Dynamics: Density and pressure P in a fluid, an element of fluid and its velocity, continuity equation and mass conservation, stream-lined motion, laminar flow, Poiseuille's equation for flow of a liquid through a pipe, Navier-Stokes equation, qualitative description of turbulence, Reynolds number. **(15 Lectures)**

TEXT BOOKS

1. Classical Mechanics, H.Goldstein, C.P. Poole, J.L. Safko, 3rd Edn. 2002, Pearson Education.
2. Mechanics, L. D. Landau and E. M. Lifshitz, 1976, Pergamon.
3. Classical Mechanics, P.S. Joag, N.C. Rana, 1st Edn., McGraw Hall.

REFERENCE BOOKS

1. Classical Electrodynamics, J.D. Jackson, 3rd Edn., 1998, Wiley.
2. The Classical Theory of Fields, L.D Landau, E.M Lifshitz, 4th Edn., 2003, Elsevier.
3. Introduction to Electrodynamics, D.J. Griffiths, 2012, Pearson Education.
4. Classical Mechanics, R. Douglas Gregory, 2015, Cambridge University Press.
5. Classical Mechanics: An introduction, Dieter Strauch, 2009, Springer.
6. Solved Problems in classical Mechanics, O.L. Delange and J. Pierrus, 2010, Oxford Press

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PHY-DE-354 : ADVANCED MATHEMATICAL PHYSICS

Credit: 6 (L- 5:T- 1: P-0) Theory: 60 Lectures

COURSE OBJECTIVES

The emphasis of the course is on application in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen. The course is intended to impart the concept of generalized mathematical constructs in terms of Group Theory, Probability Theory, Algebraic Structures (mainly Vector Spaces) and complex variables to have in-depth analysis of our physical system.

COURSE LEARNING OUTCOME

- Learning of elementary group theory, i.e., definition and properties of groups, subgroups, Homomorphism, isomorphism, normal and conjugate groups, representation of groups, Reducible and Irreducible groups. Examples and exercises.
- Learning of the theory of probability, Random variables and probability distributions, Expectation values and variance. Various examples of probability distributions used in physics. The principle of least squares.
- Learning of the basic properties of the linear vector space such as linear dependence and independence of vectors, change of basis, isomorphism and homomorphism, linear transformations and their representation by matrices.
- Learning of the basic properties of matrices, different types of matrices viz., Hermitian, skew Hermitian, orthogonal and unitary matrices and their correspondence to physical quantities, e.g, operators in quantum mechanics. They should also learn how to find the eigenvalues and eigenvectors of matrices.

BROAD CONTENTS OF THE COURSE

- Group Theory
- Probability Theory
- Linear vector space
- Matrices
- Complex variables

SKILLS TO BE LEARNED

- An understanding of how to model a given problem such as particle in a box, hydrogen atom, hydrogen atom in electric fields.
- Concept of many electron atoms, L-S and J-J couplings.
- Understanding the different Quantum Systems in atomic and nuclear physics.

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DETAILED CONTENTS OF THE COURSE

MODULE 1

Group Theory: Review of sets, Mapping and Binary Operations, Relation, Types of Relations. Groups: Elementary properties of groups, uniqueness of solution, Subgroup, Centre of a group, Co-sets of a subgroup, cyclic group, Permutation/Transformation. Homomorphism and Isomorphism of group. Normal and conjugate subgroups, Completeness and Kernel. Some special groups with operators. Matrix Representations: Reducible and Irreducible **(15 Lectures)**

MODULE 2

Probability Theory: Fundamental Probability Theorems. Conditional Probability, Bayes' Theorem, Repeated Trials, Binomial and Multinomial expansions. Random Variables and probability distributions, Expectation and Variance, Special Probability distributions: The binomial distribution, The poisson distribution, Continuous distribution: The Gaussian (or normal) distribution, The principle of least squares. **(15 Lectures)**

MODULE 3

Linear Vector Spaces: Abstract Systems. Binary Operations and Relations. Introduction to Groups and Fields. Vector Spaces and Subspaces. Linear Independence and Dependence of Vectors. Basis and Dimensions of a Vector Space. Change of basis. Homomorphism and Isomorphism of Vector Spaces. Linear Transformations. Algebra of Linear Transformations. Non-singular Transformations. Representation of Linear Transformations by Matrices. **(12 Lectures)**

MODULE 4

Matrices: Cayley- Hamiliton Theorem. Diagonalization of Matrices. Solution of Coupled Linear Ordinary Differential Equations. Functions of a Matrix **(5 Lectures)**

Complex Variables: Complex functions, analytic functions. Singular functions: poles and branch points, order of singularity, branch cuts. Integration of a function of a complex variable. Cauchy's Inequality. Cauchy's Integral formula. Simply and multiply connected region. Laurent and Taylor's expansion. Residues and Residue Theorem. Application in solving Definite Integrals. **(10 Lectures)**

MODULE 5

Linear Vector Spaces: Abstract Systems. Binary Operations and Relations. Introduction to Groups and Fields. Vector Spaces and Subspaces. Linear Independence and Dependence of Vectors. Basis and Dimensions of a Vector Space. Change of basis. Homomorphism and Isomorphism of Vector Spaces. Linear Transformations. Algebra of Linear Transformations. Non-singular Transformations. Representation of Linear Transformations by Matrices. **(15 Lectures)**

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TEXT BOOKS

1. Modern Mathematical Methods for Physicists and Engineers, C.D. Cantrell, 2011, Cambridge Univ. Press
2. Introduction to Matrices and Linear Transformations, D.T. Finkbeiner, 1978, Dover Pub.
3. Linear Algebra, W. Cheney, E.W.Cheney& D.R.Kincaid, 2012, Jones & Bartlett Learning

REFERENCE BOOKS

4. Mathematical Tools for Physics, James Nearing, 2010, Dover Publications
5. Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, and F.E. Harris, 1970, Elsevier.
6. Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole
7. Mathematical Methods for Physicis & Engineers, K.F.Riley, M.P.Hobson, S.J.Bence,
8. 3rd Ed., 2006, Cambridge University Press

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PHY-DE-355 : ELECTRONIC DEVICES AND COMMUNICATION

Credit: 4 (L- 4:T- 0: P-0) Theory: 60 Lectures

COURSE OBJECTIVES

This paper is based on advanced electronics which covers the devices such as UJT, JFET,MOSFET, CMOS etc. Process of IC fabrication is discussed in detail. Digital Data serialand parallel Communication Standards are described along with the understanding ofcommunication systems.

COURSE LEARNING OUTCOME

At the successful completion of the course the students are expected to master the following.

- UJT, JFET, MOSFET, Charge coupled Devices and Tunnel Diode.
- Power Supply and the role of Capacitance and Inductance filters.
- Active and passive filters and various types of filters.
- Multivibrators using transistors, Phase locked loops, voltage-controlled oscillators
- Basics of photolithography for IC fabrication, about masks and etching.
- Concepts of parallel and serial communication and knowledge of USB standards and GPIB.
- Basic idea of communication including different modulation techniques.

BROAD CONTENTS OF THE COURSE

- Metal oxide semiconductors, UJT, JFET, MOSFET, Charge coupled Devices and Tunnel Diode.
- Power Supply and the role of Capacitance and Inductance filters.
- Active and passive filters and various types of filters.
- Multivibrators using transistors, Phase locked loops, voltage-controlled oscillators
- Photolithography for IC fabrication, about masks and etching.
- Parallel and serial communications and USB standards and GPIB.
- Different modulation techniques

SKILLS TO BE LEARNED

Acquire knowledge and skills to understand the working principle of the following devices and instruments and practical knowledge to use them by doing experiments inlaboratory.

- UJT
- BJT
- MOSFET
- CCD
- TunnelDiodes
- Various types of PowerSupplies
- Various types ofFilters

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- Multivibrators
- Oscillators

DETAILED CONTENTS OF THE COURSE

MODULE 1

Devices: Characteristic and small signal equivalent circuits of UJT and JFET. Metal- semiconductor Junction. Metal oxide semiconductor (MOS) device. Ideal MOS and Flat Band voltage. SiO2-Si based MOS. MOSFET– their frequency limits. Enhancement and Depletion Mode MOSFETS, CMOS. Charge coupled devices. Tunnel diode. **(14 Lectures)**

MODULE 2

Power supply and Filters: Block Diagram of a Power Supply, Qualitative idea of C and L Filters. IC Regulators, Line and load regulation, Short circuit protection **(3 Lectures)**

Active and Passive Filters, Low Pass, High Pass, Band Pass and band Reject Filters **. (3 Lectures)**

Multivibrators: Astable and Monostable Multivibrators using transistors **. (3 Lectures)**

Phase Locked Loop(PLL): Phase detector(XOR & edge triggered), Voltage Controlled Oscillator (Basics, varactor). Loop Filter– Function, Loop Filter Circuits, transient response, lock and capture. Basic idea of PLL IC (565 or 4046). **(5 Lectures)**

MODULE 3

Atomic Structure: Review on atomic models, Bohr's Model – energy level diagram, drawbacks, Sommerfeld Theory, vector atom model **(5 Lectures):**

Atoms in Electric & Magnetic Fields: Orbital angular momentum and spin angular momentum Space quantization. Larmor's Theorem. Spin Magnetic Moment. Stern- Gerlach Experiment Electron Magnetic Moment and Magnetic Energy, Gyromagnetic Ratio and Bohr Magneton. **(10 Lectures)**

MODULE 4

Introduction to communication systems: Basics electronic communication system, Amplitude modulation. Modulation Index. Sideband frequencies in AM wave. CE Amplitude Modulator. Demodulation of AM wave using Diode Detector. basic idea of Frequency, Phase, Pulse and Digital Modulation including ASK, PSK, FSK. **(12 lectures)**

Digital Data Communication Standards: Serial Communications RS232, Universal Serial Bus (USB): USB standards, Types and elements of USB transfers. Parallel Communications: General Purpose Interface Bus (GPIB) Basic idea of sending data through a COM port. **(3 Lectures)**

TEXT BOOKS

1. Physics of Semiconductor Devices, S.M. Sze & K.K. Ng, 3rd Ed.2008, John Wiley & Sons
2. Electronic devices and integrated circuits, A.K. Singh, 2011, PHI Learning Pvt. Ltd.
3. Op-Amps & Linear Integrated Circuits, R.A.Gayakwad,4 Ed. 2000,PHI Learning Pvt. Ltd

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REFERENCE BOOKS

1. Electronic Devices and Circuits, A. Mottershead, 1998, PHI Learning Pvt. Ltd.
2. Electronic Communication systems, G. Kennedy, 1999, Tata McGraw Hill.
3. Introduction to Measurements & Instrumentation, A.K. Ghosh, 3rd Ed., 2009, PHI Learning
4. Semiconductor Physics and Devices, D.A. Neamen, 2011, 4th Edition, McGraw Hill
5. PC based instrumentation; Concepts & Practice, N.Mathivanan, 2007, Prentice-Hall of India

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PHY-DE-355(Practical) : ELECTRONIC DEVICES AND COMMUNICATION LABORATORY

Credit: 2 (L- 0:T- 0: P-2) Practical: 60 Hours

COURSE OBJECTIVES

The main objective of this laboratory component of PHY-DE-355P, is to understand the working principle of various types of electronic components and provide the core understanding of different amplifier, oscillators, modulator circuits. Another aim of this course component is toenlighten software-based experiment of electronics.

COURSE LEARNING OUTCOME

- Learning of the construction and use of CRO, and other experimental apparatuses used in the lab, including necessary precautions.
- Practical experience of the characterizes of semiconductor devices like JFET, MOSFET and different types of amplifiers, oscillator and modulator circuits.
- Review of experimental data analysis, sources of error and their estimationin details, writing of scientific laboratory reports including proper reporting of errors

SKILLS TO BE LEARNED

- Skills to design various types of circuits.
- Troubleshooting of electronic circuit during any kind of experiment

LIST OF EXPERIMENTS

Experiments from both Section are mandatory

SECTION-A

1) To design a power supply using bridge rectifier and study effect ofC-filter.
2) To design the active Low pass and High pass filters of givenspecification.
3) To design the active filter (wide band pass and band reject) of givenspecification.
4) To study the output and transfer characteristics of aJFET.
5) To design a common source JFET Amplifier and study its frequencyresponse.
6) To study the output characteristics of aMOSFET
7) To study the characteristics of a UJT and design a simple RelaxationOscillator.
8) To design an Amplitude Modulator usingTransistor.
9) To design PWM, PPM, PAM and Pulse code modulation usingICs.
10) To design an Astablemultivibrator of given specifications usingtransistor.
11) To study a PLL IC (Lock and capturerange).

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12) To study envelope detector for demodulation of AMsignal.

13) Study of ASK and FSKmodulator.

14) Glow an LED via USB port ofPC.

15) Sense the input voltage at a pin of USB port and subsequently glow the LED connected with another pin of USB port.

SECTION-B:

SPICE/MULTISIM simulations for electrical networks and electronic circuits

1) To verify the Thevenin and NortonTheorems.
2) Design and analyze the series and parallel LCRcircuits
3) Design the inverting and non-inverting amplifier using an Op-Amp of givengain
4) Design and Verification of op-amp as integrator anddifferentiator
5) Design the 1st order active low pass and high pass filters of given cutofffrequency
6) Design a Wein`s Bridge oscillator of givenfrequency.
7) Design clocked SR and JK Flip-Flop`s using NANDGates
8) Design 4-bit asynchronous counter using Flip-FlopICs
9) Design the CE amplifier of a given gain and its frequencyresponse.
10) Design an Astablemultivibrator using IC555 of given dutycycle.

TEXT BOOKS

1. Basic Electronics:A text lab manual, P.B. Zbar, A.P. Malvino, M.A.Miller,1994, Mc-Graw Hill
2. Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.

REFERENCE BOOKS

3. Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
4. OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edn., 2000, Prentice Hall.
5. Introduction to PSPICE using ORCAD for circuits & Electronics, M.H. Rashid, 2003, PHI Learning.
6. PC based instrumentation; Concepts & Practice, N.Mathivanan, 2007, Prentice-Hall of India

ASSESSMENT: MARKING SCHEME

Total Marks: 50

- **Internal assessment:** 10 marks
- **End term examination:** 40 marks (laboratory exam. will be conducted at the semester end).
  - Laboratory Notebook: 10 Marks
  - Experimental work and data analysis:10 Marks
  - Presentation and Viva voce: 20 Marks

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PHY-DE-356 : PHYSICS OF EARTH

Credit: 6 (L- 5:T- 1: P-0) Theory: 60 Lectures

COURSE OBJECTIVES

This course familiarizes the students with the origin of universe and role of earth in the solar system.

COURSE LEARNING OUTCOME

- This course will provide an exposure to student
- In the origin of Universe, place of Earth as a third rock revolving around Sun, its satellite Moon and in general evolution of present-day Universe.
- overview of the structure and evolution of the Earth as a dynamic planet within our solar system
- Application of physical principles of elasticity and elastic wave propagation to understand modern global seismology as a probe of the Earth's internal structure. The origin of magnetic field, Geodynamics of earthquakes and the description of seismic sources; a simple but fundamental theory of thermal convection; the distinctive rheological behaviour of the upper mantle and its top layer shall be understood.
- Climate and various roles played by water cycle, carbon cycle, nitrogen cycles in maintain steady state of earth shall be explored.
- This will enable the student to understand the contemporary dilemmas (climate change, bio diversity loss, population growth, etc.) disturbing the Earth
- In the tutorial section, through literature survey on the various aspects of health of Earth, project work / seminar presentation, he she will be to appreciate need to 'save' Earth.

BROAD CONTENTS OF THE COURSE

- The Earth and the Universe
- Structure
- Dynamical Processes
- Evolution
- Disturbing the Earth – Contemporary dilemmas

SKILLS TO BE LEARNED

Knowledge of the place of Earth in this Universe and its formation, structure and its evolution shall enable the student to appreciate the reasons for keeping Earth 'SAFE'

DETAILS CONTENTS OF THE COURSE

MODULE 1

The Earth and the Universe: (15 Lectures)

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a) Origin of universe, creation of elements and earth. A Holistic understanding of our dynamic planet through Astronomy, Geology, Meteorology and Oceanography. Introduction to various branches of Earth Sciences.
b) General characteristics and origin of the Universe. The Milky Way galaxy, solar system, Earth's orbit and spin, the Moon's orbit and spin. The terrestrial and Jovian planets. Meteorites & Asteroids. Earth in the Solar system, origin, size, shape, mass, density, rotational and revolution parameters and its age.
c) Energy and particle fluxes incident on the Earth.
d) The Cosmic Microwave Background.

MODULE 2

Structure: **(15 Lectures)**

a) The solid Earth: Mass, dimensions, shape and topography, internal structure, magnetic field, geothermal energy. How do we learn about Earth's interior?
b) The Hydrosphere: The oceans, their extent, depth, volume, chemical composition. River systems.
c) The Atmosphere: variation of temperature, density and composition with altitude, clouds.
d) The Cryosphere: Polar caps and ice sheets. Mountain glaciers.
e) The Biosphere: Plants and animals. Chemical composition, mass. Marine and land organisms.

MODULE 3

Dynamical Processes I **(15 Lectures)**

In the Solid Earth: Origin of the magnetic field. Source of geothermal energy. Convection in Earth's core and production of its magnetic field. Mechanical layering of the Earth. Introduction to geophysical methods of earth investigations. Concept of plate tectonics; sea- floor spreading and continental drift. Geodynamic elements of Earth: Mid Oceanic Ridges, trenches, transform faults and island arcs. Origin of oceans, continents, mountains and rift valleys. Earthquake and earthquake belts. Volcanoes: types products and distribution.

MODULE 4

Dynamical Processes II: **(15 Lectures)**

a) The Hydrosphere: Ocean circulations. Oceanic current system and effect of coriolis forces. Concepts of eustasy, tend – air-sea interaction; wave erosion and beach processes. Tides. Tsunamis.
b) The Atmosphere: Atmospheric circulation. Weather and climatic changes. Earth's heat budget. Cyclones.
    - Climate:
        - Earth's temperature and greenhouse effect.
        - Paleoclimate and recent climate changes.
        - The Indian monsoon system.

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c) Biosphere: Water cycle, Carbon cycle, Nitrogen cycle, Phosphorous cycle. The role of cycles in maintaining a steady state.

MODULE 5

Evolution **(15 Lectures)**

Nature of stratigraphic records, Standard stratigraphic time scale and introduction to the concept of time in geological studies. Introduction to geochronological methods in their application in geological studies. History of development in concepts of uniformitarianism, catastrophism and neptunism. Law of superposition and faunal succession. Introduction to the geology and geomorphology of Indian subcontinent.

a) Time line of major geological and biological events.
b) Origin of life on Earth.
c) Role of the biosphere in shaping the environment.
d) Future of evolution of the Earth and solar system: Death of the Earth.

TEXT BOOKS

1. Emiliani, C, 1992. Planet Earth, Cosmology, Geology and the Evolution of Life and Environment. Cambridge University Press.

REFERENCE BOOKS

1. Planetary Surface Processes, H. Jay Melosh, Cambridge University Press, 2011.
2. Consider a Spherical Cow: A course in environmental problem solving, John Harte. University Science Books
3. Holme's Principles of Physical Geology. 1992. Chapman & Hall.

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PHY-DE-357 : EXPERIMENTAL TECHNIQUES

Credit: 4 (L- 4:T- 0: P-0) Theory: (60 Lectures)

COURSE OBJECTIVES

This paper aims to describe the errors in measurement and statistical analysis of datarequired while performing an experiment. Also, students will learn the working principle,efficiency and applications of transducers & industrial instrument like digital multimeter,RTD, Thermistor, Thermocouples and Semiconductor type temperature sensors.

COURSE LEARNING OUTCOME

At the end of the course the student should be conversant with the following.

- About accuracy and precision, different types of errors and statistical analysis of data.
- About Noise and signal, signal to noise ratio, different types of noises and their identification.
- Concept of electromagnetic interference and necessity of grounding.
- About transducers and basic concepts of instrumentation-Different types of transducers and sensors.
- Working of a digital multimeter.
- Vacuum systems including ultrahigh vacuum systems.
- Conduct Experiments using different transducers including LVDT and gain hands on experience and verify the theory.

BROAD CONTENTS OF THE COURSE

- Accuracy and precision,
- Different types of errors and statistical analysis of data.
- Noise and signal, signal to noise ratio, different types of noises
- Electromagnetic interference and necessity of grounding.
- Transducers
- Different types of transducers and sensors.
- Digital multimeter.
- Vacuum systems including ultrahigh vacuum systems.

SKILLS TO BE LEARNED

- Analysis of data, making approximation and performing error analysis using basic methods of statistics.
- The working principle of transduces, their application and study of the efficiency.
- Understanding of analog and digital instruments and earns to use them in making physical measurements.
- Understanding of signal, noise, and fluctuations in making physical measurements.

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- Understanding of Impedances Bridges, Q meters as well as vacuum systems using various types of pumps and pressure gauges.

DETAILED CONTENTS OF THE COURSE

MODULE 1

Measurements: Accuracy and precision. Significant figures. Error and uncertainty analysis. Types of errors: Gross error, systematic error, random error. Statistical analysis of data (Arithmetic mean, deviation from mean, average deviation, standard deviation, chi-square) and curve fitting. Gaussian distribution. **(7 Lectures)**

Signals and Systems: Periodic and aperiodic signals. Impulse response, transfer function and frequency response of first and second order systems. Fluctuations and Noise in measurement system. S/N ratio and Noise figure. Noise in frequency domain. Sources of Noise: Inherent fluctuations, Thermal noise, Shot noise, 1/f noise. **(7 Lectures)**

MODULE 2

Transducers (working principle, efficiency, applications): Static and dynamic characteristics of measurement Systems. Zero order first order, second order and higher order systems. Electrical, Thermal and Mechanical systems. Calibration. Characteristics of Transducers. Temperature transducers: RTD, Thermistor, Thermocouples, Semiconductor type (AD590, LM35, LM75) , Linear Position transducer: Strain gauge, Piezoelectric. Inductance change transducer: Linear variable differential transformer (LVDT), Capacitance change transducers. **(15 Lectures)**

MODULE 3

Digital Multimeter: analog vs digital instruments. Block diagram of digital multimeter, principle of measurement of I, V, C. Accuracy and resolution of measurement. **(5 Lectures)**

Impedance Bridges and Q-meter: Block diagram and working principles of RLC bridge. Q-meter and its working operation. Digital LCR bridge. **(5 Lectures)**

Shielding and Grounding: Methods of safety grounding. Energy coupling. Grounding. Shielding: Electrostatic shielding. Electromagnetic Interference. **(5 Lectures)**

MODULE 4

Vacuum Systems: Characteristics of vacuum: Gas law, Mean free path. Application of vacuum. Vacuum system- Chamber, Mechanical pumps, Diffusion pump & Turbo Modular pump, Pumping speed, Pressure gauges (Macleod, Pirani, Penning, ionization). **(12 Lectures)**

Low temperature: Gas liquifiers; Cryo-fluid baths, liquid He cryostat design; closed cycle He refrigerator, low temperature measurement, **(12 Lectures)**

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TEXT BOOKS

1. Introduction to Measurements and Instrumentation, A.K. Ghosh, 3rd Edition, PHI Len.Pvt. Ltd.
2. Transducers and Instrumentation, D.V.S. Murty, 2nd Edition, PHI Learning Pvt. Ltd.
3. Instrumentation Devices and Systems, C.S. Rangan, G.R. Sarma, V.S.V. Mani, Tata McGraw Hill

REFERENCE BOOKS

1. Measurement, Instrumentation and Experiment Design in Physics and Engineering, M. Sayer and A. Mansingh, PHI Learning Pvt. Ltd.
2. Experimental Methods for Engineers, J.P. Holman, McGraw Hill
3. Principles of Electronic Instrumentation, D. Patranabis, PHI Learning Pvt. Ltd.
4. Electronic circuits: Handbook of design & applications, U.Tietze, Ch.Schenk, Springer

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PHY-DE-357 (Practical) : EXPERIMENTAL TECHNIQUES LABORATORY

Credit: 2 (L- 0:T- 0: P-2) Practical: 60 Hours

COURSE OBJECTIVES

The objective of this laboratory component of the course PHY-DE- 357P is to provide hand on experience with different types of transducers as well as to enhance their understanding about these transduces through some experiments.

COURSE LEARNING OUTCOME

- Specific measurement of instruments and experimental apparatuses used in the physics lab, with necessary precautions
- Experimental data analysis, sources of error and their estimation in detail, writing of scientific laboratory reports including proper reporting of errors. Application to the specific experiments done in the lab.

SKILLS TO BE LEARNED

- Skill to use transducer in physics laboratory

LIST OF EXPERIMENTS

1. To determine output characteristics of a LVDT & measure displacement using LVDT
2. Measurement of Strain using Strain Gauge.
3. Measurement of level using capacitive transducer.
4. To study the characteristics of a Thermostat and determine its parameters.
5. Study of distance measurement using ultrasonic transducer.
6. To calibrate Semiconductor type temperature sensor (AD590, LM35, or LM75)
7. To measure the change in temperature of ambient using Resistance Temperature Device (RTD).
8. To create vacuum in a small chamber using a mechanical (rotary) pump and measure the chamber pressure using a pressure gauge.
9. Comparison of pickup of noise in cables of different types (co-axial, single shielded, double shielded, without shielding) of 2m length, understanding of importance of grounding using function generator of mV level & an oscilloscope.
10. To design and study the Sample and Hold Circuit.
11. To design and analyze the Clippers and Clampers circuits using junction diode
12. To plot the frequency response of a microphone.
13. To measure Q of a coil and influence of frequency, using a Q-meter.

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TEXT BOOKS

1) Electronic circuits: Handbook of design and applications, U. Tietze and C. Schenk, 2008, Springer
2) Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1990, Mc-Graw Hill

REFERENCE BOOKS

1) Measurement, Instrumentation and Experiment Design in Physics & Engineering, M. Sayer and A. Mansingh, 2005, PHI Learning.

ASSESSMENT: MARKING SCHEME

Total Marks: 50

- **Internal assessment:** 10 marks
- **End term examination:** 40 marks (laboratory exam. will be conducted at the semester end).
  - Laboratory Notebook: 10 Marks
  - Experimental work and data analysis:10 Marks
  - Presentation and Viva voce: 20 Marks

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PHY-DE-358 : BIOLOGICAL PHYSICS

Credit: 6 (L- 5:T- 1: P-0) Theory: (75 Lectures)

COURSE OBJECTIVES

This course familiarizes the students with the basic facts and ideas of biology from aquantitative perspective. It shows them how ideas and methods of physics enrich our understanding of biological systems at diverse length and time scales. The course also gives them a flavor of the interface between biology, chemistry, physics and mathematics.

COURSE LEARNING OUTCOME

This course will enable students to

- Acquire mastery of the fundamental principles and applications of various branches of Physics in understanding biological systems.
- Fundamental concept thermodynamics and statistical mechanics, electricity and magnetism, will help in understating heat transfer in biomaterials.
- Relevance of chemistry principles and thermodynamics in understanding energy transfer mechanism and protein folding in biological systems.
- Necessary mathematical skills in differential equations, analysis, and linear algebra for simulation studies.
- A basic course in bioPhysics will provide proficiency in basic lab skills, including understanding and using modern instrumentation and computers.
- Exposure to complexity of life at i) the level of Cell, ii) level of multi cellular organism and iii) at macroscopic system – ecosystem and biosphere
- Exposure to models of evolution.

BROAD CONTENTS OF THE COURSE

- Overview
- Molecules of Life
- The complexity of Life
- Evolution

SKILLS TO BE LEARNED

- Basic concepts about biological physics and evolution.

DETAILS CONTENTS OF THE COURSE

MODULE 1

Overview: The boundary, interior and exterior environment of living cells. Processes: exchange of matter and energy with environment, metabolism, maintenance, reproduction, evolution. Self-

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replication as a distinct property of biological systems. Time scales and spatial scales. Universality of microscopic processes and diversity of macroscopic form. Types of cells. Multicellularity. Allometric scaling laws. **(15 lectures)**

MODULE 2

Molecules of life: Metabolites, proteins and nucleic acids. Their sizes, types and roles in structures and processes. Transport, energy storage, membrane formation, catalysis, replication, transcription, translation, signaling. Typical populations of molecules of various types present in cells, their rates of production and turnover. Energy required to make a bacterial cell. Simplified mathematical models of transcription and translation, small genetic circuits and signaling pathways. Random walks and applications to biology. **(15 lectures)**

MODULE 3

The complexity of life at the level of cell : The numbers of distinct metabolites, genes and proteins in a cell. Complex networks of molecular interactions: metabolic, regulatory and signaling networks.Dynamics of metabolic networks; the stoichiometric matrix. Living systems as complex organizations; systems biology. Models of cellular dynamics. The implausibility of life based on a simplified probability estimate, and the origin of life problem. **(15 Lectures)**

MODULE 4

Multicellular organism: Numbers and types of cells in multicellular organisms. Cell types as distinct attractors of a dynamical system. Stem cells and cellular differentiation. Pattern formation and development. **(10 lectures)**

Brain structure: neurons and neural networks. Brain as an information processing system. Associative memory models. Memories as attractors of the neural network dynamics. **(3 lectures)**

Ecosystem: Foodwebs. Feedback cycles and self-sustaining ecosystems. **(2 lectures)**

MODULE 5

Evolution: The mechanism of evolution: variation at the molecular level, selection at the level of the organism. Models of evolution. The concept of genotype-phenotype map. Examples. **(15 lectures)**

TEXT BOOKS

1. Physics in Molecular Biology; Kim Sneppen& Giovanni Zocchi (CUP 2005)
2. Biological Physics: Energy, Information, Life; Philip Nelson (W H Freeman & Co, NY, 2004)

REFERENCE BOOKS

1. Physical Biology of the Cell (2nd Edition), Rob Phillips et al (Taylor & Francis Group, London & NY, 2013)
2. An Introduction to Systems Biology; Uri Alon (Chapman and Hall/CRC, Special Indian Edition, 2013)
3. Evolution; M. Ridley (Blackwell Publishers, 2009, 3rd edition)

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PHY-CC-361 : ELECTROMAGNETIC THEORY

Credit: 4 (L- 4:T- 0: P-0) Theory: (60 Lectures)

COURSE OBJECTIVES

This core course strengthens the concepts learnt in the electricity and magnetism course to understand the properties of electromagnetic waves in vacuum and different media.

COURSE LEARNING OUTCOME

- An understanding of the Maxwell's equations, role of displacement current, gauge transformations, scalar and vector potentials, Coulomb and Lorentz gauge, boundary conditions at the interface between different media.
- Appling Maxwell's equations to deduce wave equation, electromagnetic field energy, momentum and angular momentum density.
- Analyzing the phenomena of wave propagation in the unbounded, bounded, vacuum, dielectric, guided and unguided media.
- Understanding the laws of reflection and refraction and to calculate the reflection and transmission coefficients at plane interface in bounded media.
- Understanding the linear, circular and elliptical polarisations of em waves. Production as well as detection of waves in laboratory.
- Understanding propagation of em waves in anisotropic media, uni-axial and biaxial crystals phase retardation plates and their uses.
- Understanding the concept of optical rotation, theories of optical rotation and their experimental rotation, calculation of angle rotation and specific rotation.
- Understanding the features of planar optical wave guide and obtain the Electric field components, Eigen value equations, phase and group velocities in a dielectric wave guide.
- Understanding the fundamentals of propagation of electromagnetic waves through optical fibres and calculate numerical apertures for step and graded indices and transmission losses.
- Opportunity to perform experiments Demonstrating principles of Interference, Refraction and diffraction of light using monochromatic sources of light. Demonstrate interference, Refraction and Diffraction using microwaves.
- Determination the refractive index of glass and liquid using total internal reflection of light.
- Verifying the laws of Polarisation for plane polarised light.
- Determination Polarisation of light by Reflection and determine the polarization angle off or air-glass surface
- Determination the wavelength and velocity of Ultrasonic waves in liquids using diffraction.
- Studying specific rotation of sugar using Polarimeter.
- Analyzing experimentally the Elliptically Polarised light using Babinet's Compensator
- Studying Experimentally the angle dependence of radiation for a simple dipole antenna
- Planning and executing 2-3 group projects for designing new experiments based on the Syllabi.

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BROAD CONTENTS OF THE COURSE

- Review of Maxwell's equations
- EM wave propagation in unbounded media of various types
- EM wave propagation in bounded media separated by two types of media
- Polarization of electromagnetic waves
- Wave guides

SKILLS TO BE LEARNED

- Comprehend the role of Maxwell's equation in unifying electricity and magnetism.
- Deriving expression for
    a) Energy density
    b) Momentum density
    c) Angular momentum density of the electromagnetic field
- Learning the implications of Gauge invariance in EM theory in solving the wave equations and develop the skills to actually solve the wave equation in various media like
    a) Vacuum
    b) Dielectric medium
    c) Conducting medium
    d) Dilute plasma
- Deriving and understanding the properties, EM wave passing through the interface between two media like
    a) Reflection
    b) Refraction
    c) Transmission
    d) EM waves
- Learning of the basic physics associated with the polarization of electromagnetic waves by doing various experiments for:
    a) Plane polarized light
    b) Circularly polarized light
    c) Circularly polarized light
- Learning of the application of EM theory to
    a) Wave guides of various types
    b) Optical fibers in theory and experiment

DETAILED CONTENTS OF THE COURSE

MODULE 1

Maxwell Equations: Maxwell's equations. Displacement Current. Vector and Scalar Potentials. Gauge Transformations: Lorentz and Coulomb Gauge. Boundary Conditions at Interface between Different Media. Wave Equations. Plane Waves in Dielectric Media. Poynting Theorem and Poynting Vector.

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Electromagnetic (EM) Energy Density. Physical Concept of Electromagnetic Field Energy Density, Momentum Density and Angular Momentum Density. **(15 Lectures)**

MODULE 2

EM Wave Propagation in Unbounded Media: Plane EM waves through vacuum and isotropic dielectric medium, refractive index and dielectric constant, wave impedance. Propagation through conducting media, relaxation time, skin depth. **(5 Lectures)**

EM Wave in Bounded Media: Boundary conditions at a plane interface between two media. Reflection & Refraction of plane waves at plane interface between two dielectric media-Laws of Reflection & Refraction. Fresnel's Formulae for perpendicular & parallel polarization cases, Brewster's law. Reflection & Transmission coefficients. Total internal reflection, **(10 Lectures)**

MODULE 3

Polarization of Electromagnetic Waves: Description of Linear, Circular and Elliptical Polarization. Propagation of E.M. Waves in Anisotropic Media. Symmetric Nature of Dielectric Tensor. Fresnel's Formula. Uniaxial and Biaxial Crystals. Light Propagation in Uniaxial Crystal. Double Refraction. Polarization by Double Refraction. Nicol Prism. Ordinary & extraordinary refractive indices. Production & detection of Plane, Circularly and Elliptically Polarized Light. Phase Retardation Plates: Quarter-Wave and Half-Wave Plates. Babinet Compensator and its Uses. Analysis of Polarized Light **(15 Lectures)**

MODULE 4

Rotatory Polarization: Optical Rotation. Biot's Laws for Rotatory Polarization. Fresnel's Theory of optical rotation. Calculation of angle of rotation. Experimental verification of Fresnel's theory. Specific rotation. Laurent's half-shade polarimeter. **(7 Lectures)**

Wave Guides: Planar optical wave guides. Planar dielectric wave guide. Condition of continuity at interface. Phase shift on total reflection. Eigenvalue equations. Phase and group velocity of guided waves. Field energy and Power transmission **. (8 Lectures)**

TEXT BOOKS

1. Introduction to Electrodynamics, D.J. Griffiths, 3rd Ed., 1998, Benjamin Cummings.
2. Elements of Electromagnetics, M.N.O. Sadiku, 2001, Oxford University Press.

REFERENCE BOOKS

3. Introduction to Electromagnetic Theory, T.L. Chow, 2006, Jones & Bartlett Learning
4. Fundamentals of Electromagnetics, M.A.W. Miah, 1982, Tata McGraw Hill
5. Electromagnetic field Theory, R.S. Kshetrimayun, 2012, Cengage Learning
6. Engineering Electromagnetic, Willian H. Hayt, 8th Edition, 2012, McGraw Hill.
7. Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer

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PHY-CC-361 (Practical) : PHYSICS LABORATORY XIII

Credit: 2 (L- 0:T- 0: P-2) Practical: 60 Hours

COURSE OBJECTIVES

This is the laboratory component of the course PHY CC 361: Electromagnetic Theory. The objective of this component is to explain the different optical and electromagneticphenomena experimentally

COURSE LEARNING OUTCOME

- Construction and use of specific measurement instruments and experimental apparatuses used in the lab, with necessary precautions.
- review of experimental data analysis, sources of error and their estimationin detail, writing of scientific laboratory reports including proper reporting of errors.

SKILLS TO BE LEARNED

- Arrangement and tuning of optical components of Physics in Laboratory experiment.
- Use of various types of optical and electromagnetic detectors.

DETAILED CONTENTS OF THE COURSE

1. To verify the law of Malus for plane polarized light.
2. To determine the specific rotation of sugar solution using Polarimeter.
3. To analyze elliptically polarized Light by using a Babinet's compensator.
4. To study dependence of radiation on angle for a simple Dipole antenna.
5. To determine the wavelength and velocity of ultrasonic waves in a liquid (Kerosene Oil, Xylene, etc.) by studying the diffraction through ultrasonic grating.
6. To study the reflection, refraction of microwaves
7. To study Polarization and double slit interference in microwaves.
8. To determine the refractive index of liquid by total internal reflection using Wollaston's air- film.
9. To determine the refractive Index of (1) glass and (2) a liquid by total internal reflection using a Gaussian eyepiece.
10. To study the polarization of light by reflection and determine the polarizing angle for air- glass interface.
11. To verify the Stefan`s law of radiation and to determine Stefan's constant.
12. To determine the Boltzmann constant using V-I characteristics of PN junction diode.

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TEXT BOOKS

1) A Text Book of Practical Physics, I.Prakash& Ramakrishna, 11th Ed., 2011, Kitab Mahal
2) Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House

REFERENCE BOOKS

1) Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Ed. Heinemann Edu. Pub.
2) Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer

ASSESSMENT: MARKING SCHEME

Total Marks: 50

- **Internal assessment:** 10 marks
- **End term examination:** 40 marks (laboratory exam. will be conducted at the semester end).
  - Laboratory Notebook: 10 Marks
  - Experimental work and data analysis:10 Marks
  - Presentation and Viva voce: 20 Marks

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PHY-CC- 362 : STATISTICAL MECHANICS

Credit: 4 (L- 4:T- 0: P-0) Theory: (60 Lectures)

COURSE OBJECTIVES

Statistical Mechanics deals with the derivation of the macroscopic parameters (internal energy, pressure, specific heat etc.) of a physical system consisting of large number of particles (solid, liquid or gas) from knowledge of the underlying microscopic behavior of atoms and molecules that comprises it. The main objective of this course work is to introduce the techniques of Statistical Mechanics which has applications in various fields including Astrophysics, Semiconductors, Plasma Physics, Bio-Physics etc. and in many other directions.

COURSE LEARNING OUTCOME

- Understanding of the concepts of microstate, macrostate, ensemble, phase space, thermodynamic probability and partition function.
- Understanding of the combinatoric studies of particles with their distinguishably or indistinguishably nature and conditions which lead to the three different distribution laws e.g. Maxwell-Boltzmann distribution, Bose-Einstein distribution and Fermi-Dirac distribution laws of particles and their derivation.
- Comprehending and articulating the connection as well as dichotomy between classical statistical mechanics and quantum statistical mechanics.
- Learning of application of the classical statistical mechanics to derive the law of equipartition of energy and specific heat.
- Understanding of the Gibbs paradox, equipartition of energy and concept of negative temperature in two level system.
- Learning of to derive classical radiation laws of black body radiation. Wiens law, Rayleigh Jeans law, ultraviolet catastrophe. Saha ionization formula.
- Learning to calculate the macroscopic properties of degenerate photon gas using BE distribution law, understand Bose-Einstein condensation law and liquid Helium. derivation of Plank's law
- Understanding of the concept of Fermi energy and Fermi level, calculate the macroscopic properties of completely and strongly degenerate Fermi gas, electronic contribution to specific heat of metals.
- Understanding of the application of F-D statistical distribution law to derive thermodynamic functions of a degenerate Fermi gas, electron gas in metals and their properties.
- Calculating the electron degeneracy pressure and ability to understand the Chandrasekhar mass limit, stability of white dwarfs against gravitational collapse.
- In the laboratory course, the students will an opportunity to verify Stefan's Law of radiation and determine Stefan's constant.
- Designing and performing some experiments to determine Boltzmann' Constant.
- Use of Computer simulations to study:

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a) Planck's Black Body radiation Law and compare with the Wien's Law and Raleigh - Jean's Law in appropriate temperature region.
b) Specific Heat of Solids by comparing, Dulong-Petit, Einstein's and Debye's Laws and study their temperature dependence

- Comparing the following distributions as a function of temperature for various energies and the parameters of the distribution functions:
  a) Maxwell-Boltzmann distribution
  b) Bose-Einstein distribution
  c) Fermi-Dirac distribution

BROAD CONTENTS OF THE COURSE

- Classical Statistics
- Quantum Theory of Radiation
- Bose-Einstein Statistics and its Applications
- Fermi-Dirac Statistics and its Applications.

SKILLS TO BE LEARNED

- The basic concepts and definition of physical quantities in classical statistics and classical distribution law.
- The application of classical statistics to theory of radiation.
- Comprehend the failure of classical statistics and need for quantum statistics.
- The application of quantum statistics to derive and understand.
  a) Bose Einstein statistics and its applications to radiation.
  b) Fermi-Dirac statistic and its applications to quantum systems.

DETAILED CONTENTS OF THE COURSE

MODULE 1

Classical Statistics: Macrostate& Microstate, Elementary Concept of Ensemble, PhaseSpace, Entropy and Thermodynamic Probability, Maxwell-Boltzmann Distribution Law, Partition Function, Thermodynamic Functions of an Ideal Gas, Classical Entropy Expression, Gibbs Paradox, Sackur Tetrode equation, Law of Equipartition of Energy (with proof) – Applications to Specific Heat and its Limitations, Thermodynamic Functions of a Two-Energy Levels System, Negative Temperature. **(18 Lectures)**

MODULE 2

Classical Theory of Radiation: Properties of Thermal Radiation. Blackbody Radiation. Pure temperature dependence. Kirchhoff's law. Stefan-Boltzmann law: Thermodynamic proof. Radiation Pressure. Wien's Displacement law. Wien's Distribution Law. Saha's Ionization Formula. Rayleigh-Jean's Law. Ultraviolet Catastrophe. **(9 Lectures)**

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Quantum Theory of Radiation: Spectral Distribution of Black Body Radiation. Planck's Quantum Postulates. Planck's Law of Blackbody Radiation: Experimental Verification. Deduction of (1) Wien's Distribution Law, (2) Rayleigh-Jeans Law, (3) Stefan-Boltzmann Law, (4) Wien's Displacement law from Planck's law. **(5 Lectures).**

MODULE 3

Bose-Einstein Statistics: B-E distribution law, Thermodynamic functions of a strongly Degenerate Bose Gas, Bose Einstein condensation, properties of liquid He (qualitative description), Radiation as a photon gas and Thermodynamic functions of photon gas. Bose derivation of Planck's law. **(15 Lectures)**

MODULE 4

Fermi-Dirac Statistics: Fermi-Dirac Distribution Law, Thermodynamic functions of a Completely and strongly Degenerate Fermi Gas, Fermi Energy, Electron gas in a Metal, Specific Heat of Metals, Relativistic Fermi gas, White Dwarf Stars, Chandrasekhar Mass Limit. **(15 Lectures)**

TEXT BOOKS

1. Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 1996, Oxford University Press.
2. Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill

REFERENCE BOOKS

1. Statistical and Thermal Physics, S. Lokanathan and R.S. Gambhir. 1991, Prentice Hall
2. Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.
3. Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer
4. An Introduction to Statistical Mechanics & Thermodynamics, R.H. Swendsen, 2012, Oxford Univ. Press

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PHY-CC-362 (Practical): PHYSICS LABORATORY XIV

Credit: 2 (L- 0:T- 0: P-2) Practical: 60 Hours

COURSE OBJECTIVES

This is the laboratory component of the course PHY CC 362: Statistical Mechanics. The objective of this component is to provide the core concept of statistical mechanics through some small analysis and experiment in SciLab through computer programming

COURSE LEARNING OUTCOME

- Analysis of different phenomenon through computer programming
- Use of numerical simulations for solving the problems based on Statistical Mechanics.

SKILLS TO BE LEARNED

- Computational knowledge on solving problems of Statistical Mechanics.

DETAILED CONTENTS OF THE COURSE

1. Computational analysis of the behavior of a collection of particles in a box that satisfy Newtonian mechanics and interact via the Lennard-Jones potential, varying the total number of particles N and the initial conditions:
    a) Study of local number density in the equilibrium state (i) average; (ii) fluctuations
    b) Study of transient behavior of the system (approach to equilibrium)
    c) Relationship of large N and the arrow of time
    d) Computation of the velocity distribution of particles for the system and comparison with the Maxwell velocity distribution
    e) Computation and study of mean molecular speed and its dependence on particle mass
    f) Computation of fraction of molecules in an ideal gas having speed near the most probable speed
2. Computation of the partition function Z(β) for examples of systems with a finite number of single particle levels (e.g., 2 level, 3 level, etc.) and a finite number of non-interacting particles N under Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein statistics:
    a) Study of how Z(β), average energy <E>, energy fluctuation ΔE, specific heat at constant volume Cv, depend upon the temperature, total number of particles N and the spectrum of single particle states.
    b) Ratios of occupation numbers of various states for the systems considered above
    c) Computation of physical quantities at large and small temperature T and comparison of various statistics at large and small temperature T.
3. Plot Planck's law for Black Body radiation and compare it with Raleigh-Jeans Law at high temperature and low temperature.

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4. Plot Specific Heat of Solids (a) Dulong-Petit law, (b) Einstein distribution function, (c) Debye distribution function for high temperature and low temperature and compare them for these two cases.
5. Plot the following functions with energy at different temperatures
    a) Maxwell-Boltzmanndistribution
    b) Fermi-Diracdistribution
    c) Bose-Einsteindistribution.

TEXT BOOKS

1. Statistical and Thermal Physics with computer applications, Harvey Gould and Jan Tobochnik, Princeton University Press,2010.
2. Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A. VandeWouwer, P. Saucez, C. V. Fernández. 2014Springer

REFERENCE BOOKS

1. Elementary Numerical Analysis, K.E.Atkinson, 3 rd E d n .2007, Wiley IndiaEdition
2. Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.
3. Introduction to Modern Statistical Mechanics, D. Chandler, Oxford University Press,1987
4. Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986,Narosa.
5. Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009,Springer
6. Scilab Image Processing: L.M.Surhone. 2010, Betascript Pub.

ASSESSMENT: MARKING SCHEME

Total Marks: 50

- **Internal assessment:** 10 marks
- **End term examination:** 40 marks (laboratory exam. will be conducted at the semester end).
    - Laboratory Notebook: 10 Marks
    - Programming and problem solving : 15 Marks
    - Viva voce: 15 Marks

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PHY-DE-363 : NUCLEAR AND PARTICLE PHYSICS

Credit: 6 (L- 5:T- 1: P-0) Theory: (75 Lectures)

COURSE OBJECTIVES

The objective of the course is to impart the understanding of the sub atomic particles and their properties. It will emphasize to gain knowledge about the different nuclear techniques and their applications in different branches Physics and societal application. The course will focus on the developments of problem-based skills.

COURSE LEARNING OUTCOME

- Learn the ground state properties of a nucleus – the constituents and their properties, mass number and atomic number, relation between the mass number and the radius and the mass number, average density, range of force, saturation property, stability curve, the concepts of packing fraction and binding energy, binding energy per nucleon vs. mass number graph, explanation of fusion and fission from the nature of the binding energy graph.
- Know about the nuclear models and their roles in explaining the ground state properties of the nucleus –(i) the liquid drop model, its justification so far as the nuclear properties are concerned, the semi-empirical mass formula, (ii) the shell model, evidence of shell structure, magic numbers, predictions of ground state spin and parity, theoretical deduction of the shell structure, consistency of the shell structure with the Pauli exclusion principles.
- Learn about the process of radioactivity, the radioactive decay law, the emission of alpha, beta and gamma rays, the properties of the constituents of these rays and the mechanisms of the emissions of these rays, outlines of Gamow's theory of alpha decay and Pauli's theory of beta decay with the neutrino hypothesis, the electron capture, the fine structure of alpha particle spectrum, the Geiger-Nuttall law, the radioactive series.
- Learn the basic aspects of nuclear reactions, the Q-value of such reaction and its derivation from conservation laws, The reaction cross-sections, the types of nuclear reactions, direct and compound nuclear reactions, Rutherford scattering by Coulomb potential.
- Learn some basic aspects of interaction of nuclear radiation with matter- interaction of gamma ray by photoelectric effect, Compton scattering and pair production, energy loss due to ionization, Cerenkov radiation.
- Learn about the detectors of nuclear radiations- the Geiger-Mueller counter, the scintillation counter, the photo-multiplier tube, the solid state and semiconductor detectors.
- The students are expected to learn about the principles and basic constructions of particle accelerators such as the Van-de-Graff generator, cyclotron, betatron and synchrotron. They should know about the accelerator facilities in India.
- Gain knowledge on the basic aspects of particle Physics – the fundamental interactions, elementary and composite particles, the classifications of particles: leptons, hadrons (baryons and mesons), quarks, gauge bosons. The students should know about the quantum numbers of

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particles: energy, linear momentum, angular momentum, isospin, electric charge, colour charge, strangeness, lepton numbers, baryon number and the conservation laws associated with them.

BROAD CONTENTS OF THE COURSE

- General properties of nuclei
- Nuclear models
- Radioactive decays
- Nuclear reactions
- Interaction of nuclear radiation with matter
- Detectors for nuclear interaction
- Particle accelerators
- Elementary particles and their properties

SKILLS TO BE LEARNED

- Skills to describe and explain the properties of nuclei and derive them from various models of nuclear structure.
- To understand, explain and derive the various theoretical formulation of nuclear disintegration like α decay, β decay and γ decays.
- Develop basic understanding of nuclear reactions and decays with help of theoretical formulate and laboratory experiments.
- Skills to develop basic understanding of the interaction of various nuclear radiation with matter in low and high energy …….
- Ability to understand, construct and operate simple detector systems for nuclear radiation and training to work with various types of nuclear accelerators.
- Develop basic knowledge of elementary particles as fundamental constituent of matter, their properties, conservation laws during their interactions with matter.

DETAILED CONTENTS OF THE COURSE

MODULE 1

General Properties of Nuclei: Constituents of nucleus and their Intrinsic properties, quantitative facts about mass, radii, charge density (matter density), average binding energy and its variation with mass number, main features of binding energy curve, N/A plot, angular momentum, parity, magnetic moment, electric moments, nuclear excites states. **(15 Lectures)**

MODULE 2:

Radioactivity decay: (a) Alpha decay: basics of α-decay processes, theory of α-emission, Gamow factor, Geiger Nuttall law, α-decay spectroscopy. (b) β -decay: energy kinematics for β decay, positron emission,

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electron capture, neutrino hypothesis. (c) Gamma decay: Gamma rays' emission & kinematics, internal conversion. **(15 Lectures)**

MODULE 3

Nuclear Models: Liquid drop model approach, semi empirical mass formula and significance of its various terms, condition of nuclear stability, two nucleon separation energies, Fermi gas model (degenerate fermion gas, nuclear symmetry potential in Fermi gas), evidence for nuclear shell structure, nuclear magic numbers, basic assumption of shell model, concept of mean field, residual interaction, concept of nuclear force. **(15 Lectures)**

MODULE 4

Nuclear Reactions: Types of Reactions, Conservation Laws, kinematics of reactions, Q-value, reaction rate, reaction cross section, Concept of compound and direct Reaction, resonance reaction, Coulomb scattering (Rutherford scattering). **(8 Lectures)**

Interaction of Nuclear Radiation with matter: Energy loss due to ionization (Bethe-Block formula), energy loss of electrons, Cerenkov radiation. Gamma ray interaction through matter, photoelectric effect, Compton scattering, pair production, neutron interaction with matter. **(7 Lectures)**

MODULE 5

Particle physics: Particle interactions; basic features, types of particles and its families. Symmetries and Conservation Laws: energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin, Strangeness and charm, concept of quark model, color quantum number and gluons. **(15 Lectures)**

TEXT BOOKS

1. Introductory nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).
2. Concepts of nuclear physics by Bernard L. Cohen. (Tata Mcgraw Hill, 1998).
3. Introduction to the physics of nuclei & particles, R.A. Dunlap. (Thomson Asia, 2004).

REFERENCE BOOKS

1. Introduction to High Energy Physics, D.H. Perkins, Cambridge Univ. Press
2. Introduction to Elementary Particles, D. Griffith, John Wiley & Sons
3. Quarks and Leptons, F. Halzen and A.D. Martin, Wiley India, New Delhi
4. Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K. Heyde (IOP- Institute of Physics Publishing, 2004).
5. Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).
6. Physics and Engineering of Radiation Detection, Syed Naeem Ahmed (Academic Press, Elsevier, 2007).
7. Theoretical Nuclear Physics, J.M. Blatt & V.F.Weisskopf (Dover Pub.Inc., 1991)

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PHY-DE-364 : COMMUNICATION ELECTRONICS

Credit: 4 (L- 4:T- 0: P-0) Theory: (60 Lectures)

COURSE OBJECTIVES

This paper aims to describe the concepts of electronics in communication and communication techniques based on Analog Modulation, Analog and digital Pulse Modulation. Communication and Navigation systems such as GPS and mobile telephony system are also introduced. This paper will essentially connect the text book knowledge with the most popular communication technology in real world.

COURSE LEARNING OUTCOME

At the end of the course the student is expected to have an idea/concept of the following,

- Electromagnetic spectra and different frequency bands.
- Modulation, different types of modulation and about super heterodyne receivers.
- Concept of sampling, sampling theorem and multiplexing.
- Digital transmission, encoding and decoding.
- Satellite communication including uplinking and downlinking.
- Mobile communication/telephony and concepts of cell telephony.
- 2G, 3G, 4G and 5G (Quantitative).
- Apply the theory that they have learned in the theory class to gain hands on experience in building modulation and demodulation circuits; Transmitters and Receivers for AM and FM. Also to construct TDM, PAM, PWM, PPM and ASK, PSK and FSK modulator and verify their results.

BROAD CONTENTS OF THE COURSE

- Electromagnetic spectra and different frequency bands.
- Modulation, different types of modulation and super heterodyne receivers.
- Sampling, sampling theorem and multiplexing.
- Digital transmission, encoding and decoding.
- Satellite communication
- Mobile communication/telephony and concepts of cell telephony.
- 2G, 3G, 4G and 5G (Quantitative).

SKILLS TO BE LEARNED

- Learn the skills to understand the basic concepts of communication.
- Learn the techniques of different types of modulation of electromagnetic signals like
    - Amplitude Modulation
    - Frequency Modulation
    - Phase Modulation
    - Analog Pulse Modulation

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- Digital Pulse Modulation
- Learn basics of satellite communication.
- Learn concepts and application of mobile telephony system.

DETAILED CONTENTS OF THE COURSE

MODULE 1

Introduction to communication – means and modes. Need for modulation. Block diagram of an electronic communication system. Brief idea of frequency allocation for radio communication system in India (TRAI). Electromagnetic communication spectrum, band designations and usage. Channels and base-band signals. Concept of Noise, signal-to-noise (S/N) ratio. **(8 Lectures)**

MODULE 2

Analog Modulation: Amplitude Modulation, modulation index and frequency spectrum. Generation of AM (Emitter Modulation), Amplitude Demodulation (diode detector), Concept of Single side band generation and detection. Frequency Modulation (FM) and Phase Modulation (PM), modulation index and frequency spectrum, equivalence between FM and PM, Generation of FM using VCO, FM detector (slope detector), Qualitative idea of Super heterodyne receiver. **(12 Lectures)**

MODULE 3

Analog Pulse Modulation: Channel capacity, Sampling theorem, Basic Principles-PAM, PWM, PPM, modulation and detection technique for PAM only, Multiplexing. **(7 Lectures)**

Digital Pulse Modulation: Need for digital transmission, Pulse Code Modulation, Digital Carrier Modulation Techniques, Sampling, Quantization and Encoding. Concept of Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying (PSK), and Binary Phase Shift Keying (BPSK). **(8 Lectures)**

MODULE 4

Mobile Telephony System – Basic concept of mobile communication, frequency bandsused in mobile communication, concept of cell sectoring and cell splitting, SIM number, IMEI number, need for data encryption, architecture (block diagram) of mobile communication network, idea of GSM, CDMA, TDMA and FDMA technologies, simplified block diagram of mobile phone handset, 2G, 3G and 4G concepts (qualitative only). **(7 Lectures)**

Satellite Communication– Introduction, need, Geosynchronous satellite orbits, geostationary satellite advantages of geostationary satellites. Satellite visibility, transponders (C - Band), path loss, ground station, simplified block diagram of earth station. Uplink and downlink. **(7 Lectures)**

GPS navigation system (qualitative idea only) **(1 Lecture)**

TEXT BOOKS

1. Electronic Communications, D. Roddy and J. Coolen, Pearson Education India.

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2. Advanced Electronics Communication Systems- Tomasi, 6th edition, Prentice Hall.
3. Electronic Communication systems, G. Kennedy, 3rd Edn., 1999, Tata McGraw Hill.

REFERENCE BOOKS

4. Principles of Electronic communication systems – Frenzel, 3rd edition, McGraw Hill
5. Communication Systems, S. Haykin, 2006, Wiley India
6. Electronic Communication system, Blake, Cengage, 5th edition.
7. Wireless communications, Andrea Goldsmith, 2015, Cambridge University Press

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PHY-CC-364 (Practical): COMMUNICATION ELECTRONICS LABORATORY

Credit: 2 (L- 0:T- 0: P-2) Practical: 60 Hours

COURSE OBJECTIVES

This is the laboratory component of the course on Communication Electronics (PHY DE 364P). The coruse objective is to Familiarize the students with basic analog communication systems. Integrate theory with experiments so that the experiments so that the students appreciate the knowledge gained from the theory course, e.g., amplitude and frequency modulation, pulse modulation

COURSE LEARNING OUTCOME

After studying this course, the students shall be able to:

- Learn in depth concept modulation and how it is practically done in communication systems.
- Get the practical idea about different way pulse modulation techniques.

SKILLS TO BE LEARNED

- Skill to test and troubleshoot parts of communication system

LIST OF EXPERIMENTS

1) To design an Amplitude Modulator using Transistor
2) To study envelope detector for demodulation of AM signal
3) To study FM - Generator and Detector circuit
4) To study AM Transmitter and Receiver
5) To study FM Transmitter and Receiver
6) To study Time Division Multiplexing (TDM)
7) To study Pulse Amplitude Modulation (PAM)
8) To study Pulse Width Modulation (PWM)
9) To study Pulse Position Modulation (PPM)
10) To study ASK, PSK and FSK modulators

TEXT BOOKS

1. Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A.Miller,1994, Mc-Graw Hill

REFERENCE BOOKS

1. Electronic Communication systems, G. Kennedy, 1999, Tata McGraw Hill.
2. Electronic Communication system, Blake, Cengage, 5th edition.

ASSESSMENT: MARKING SCHEME

Total Marks: 50

- **Internal assessment:** 10 marks
- **End term examination:** 40 marks (laboratory exam. will be conducted at the semester end).
  - Laboratory Notebook: 10 Marks
  - Experimental work and data analysis: 10 Marks
  - Presentation and Viva voce: 20 Marks

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PHY-DE-365 : ATMOSPHERIC PHYSICS

Credit: 4 (L- 4:T- 0: P-0) Theory: (60 Lectures)

COURSE OBJECTIVES

This paper aims to describe the characteristics of the Earth's atmospheric thermal structure and chemical composition. It enables to learn remote sensing techniques to explore atmospheric processes and helps to understand long term oscillations and fluid system dynamics which control climate change. Also, it delineates characteristics of pollutants and aerosols variability in the lower and middle atmosphere.

COURSE LEARNING OUTCOME

- Good knowledge of Earth's atmosphere, its composition, effective temperature, Greenhouse effect. Hydrostatic equation and atmospheric thermodynamics. Local winds, clouds, fog, monsoon, cyclones, sea breeze and land breeze and thunderstorms etc.
- Essential knowledge of the instruments of meteorological observation, meteorological processes and systems.
- Understanding atmospheric dynamics, fundamental forces, conservation laws, rotating coordinate system and equations of motion. Circulation, vorticity, various types of circulations, atmospheric oscillations: biannual, annual and semi-annual oscillations.
- Understanding atmospheric waves. Surface water waves, accoustic waves, buoyancy waves, atmospheric gravity waves (AGW) and its propagation in non-homogeneous medium, Lamb and Rossy waves and their propagation in 3-dimension. Wave absorption and non linear effects.
- Skills to use atmospheric Radar and Lidar to study atmospheric phenomenon, basic knowledge of Radars and Lidars including Radar equation and signal processing. Develop numerical skills to do data analysis from Radar and Lidar.
- Knowledge of the classification and properties of aerosols, their concentrations and size distribution. Production and removal of aerosols. Radiative and health effects and observation techniques for aerosols.
- Understanding the absorption and scattering of solar radiation, Rayleigh scattering and Mie scattering, Boyer-Lambert law, optical phenomenon in atmosphere. Basics of radiometry.
- Through computer simulations in the laboratory course student will learn
- Atmospheric wave using Dispersion relations
- Kelvin waves, Rossby waves and Mountain waves
- Offline and if possible online processing of RADAR data
- VHF RADAR
- X-band RADAR
- UHF RADAR
- Offline and Online processing of LIDAR data
- Study of Radiosonde data and its interpretation in terms of the atmospheric parameters

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- Interpretation of the satellite data using radio Occultation technique
- Time Series Analysis of Temperature using long term data and implications for climate change

BROAD CONTENTS OF THE COURSE

- General features of Earth's atmosphere.
- Atmospheric dynamics
- Atmospheric waves
- Atmospheric Radar and Lidar
- Atmospheric Aerosols.

SKILLS TO BE LEARNED

- Develop skills to describe, understand and make measurements of various parameters to describe the physics of earth's atmosphere.
- Learn skills to formulate, solve the theoretical equations describing the atmospheric dynamics and develop software to simulate and demonstrate in laboratory the various atmospheric phenomenon like.
- Atmospheric oscillations of various types.
- Atmospheric waves of various types.
- Learn the physics and equations for signal processing with help of RADAR AND LIDAR and performing data analysis to understand atmospheric phenomenon.
- Learn to make various types of theoretical and experimental analyses to explore the atmospheric aerosols and the effect of solar and cosmic radiation on aerosols.
- Develop a theoretical and experimental understanding of the absorption and scattering of solar radiation with matter.

DETAILED CONTENTS OF THE COURSE

MODULE 1

General features of Earth's atmosphere: Thermal structure of the Earth's Atmosphere, Ionosphere, Composition of atmosphere, Hydrostatic equation, Potential temperature, Atmospheric Thermodynamics, Greenhouse effect and effective temperature of Earth, Local winds, monsoons, fogs, clouds, precipitation, Atmospheric boundary layer, Sea breeze and land breeze. Instruments for meteorological observations, including RS/RW, meteorological processes and different systems, fronts, Cyclones and anticyclones, thunderstorms. **(15 Lectures)**

MODULE 2

Atmospheric Dynamics: Scale analysis, Fundamental forces, Basic conservation laws, The Vectorial form of the momentum equation in rotating coordinate system, scale analysis of equation of motion, Applications of the basic equations, Circulations and vorticity, Atmospheric oscillations, Quasi biennial

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oscillation, annual and semi-annual oscillations, Mesoscale circulations, The general circulations, Tropical dynamics. **(8 Lectures)**

Atmospheric Waves: Surface water waves, wave dispersion, acoustic waves,buoyancy waves, propagation of atmospheric gravity waves (AGWs) in a nonhomogeneous medium, Lamb wave, Rossby waves and its propagation in three dimensions and in sheared flow, wave absorption, non-linear consideration **(7 Lectures)**

MODULE 3

Atmospheric Radar and Lidar: Radar equation and return signal, Signal processing and detection, Various type of atmospheric radars, Application of radars to study atmospheric phenomena, Lidar and its applications, Application of Lidar to study atmospheric phenomenon. Data analysis tools and techniques. **(15 Lectures)**

MODULE 4

Atmospheric Aerosols: Spectral distribution of the solar radiation, Classification and properties of aerosols, Production and removal mechanisms, Concentrations and size distribution, Radiative and health effects, Observational techniques for aerosols, Absorption and scattering of solar radiation, Rayleigh scattering and Mie scattering, Bouguert-Lambert law, Principles of radiometry, Optical phenomena in atmosphere, Aerosol studies using Lidars. **(15 Lectures)**

TEXT BOOKS

1. Fundamental of Atmospheric Physics – Murry L Salby; Academic Press, Vol 61, 1996

REFERENCE BOOKS

1. The Physics of Atmosphere – John T. Houghton; Cambridge University press;3rd edn. 2002.
2. An Introduction to dynamic meteorology – James R Holton; Academic Press, 2004

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PHY-CC-365 (Practical): ATMOSPHERIC PHYSICS LABORATORY

Credit: 2 (L- 0:T- 0: P-2) Practical: 60 Hours

COURSE OBJECTIVES

The aim of this laboratory component to give an idea about analysis of various atmospheric data using computer software like SciLab. It will give better understanding to the students they have studies in the course theocratically.

COURSE LEARNING OUTCOME

- Through computer simulations in the laboratory course student will learn
- Atmospheric wave using Dispersion relations
- Kelvin waves, Rossby waves and Mountain waves
- Offline and if possible online processing of RADAR data
  a) VHF RADAR
  b) X-band RADAR
  c) UHF RADAR
- Offline and Online processing of LIDAR data
- Study of Radiosonde data and its interpretation in terms of the atmospheric parameters
- Interpretation of the satellite data using radio Occultation technique
- Time Series Analysis of Temperature using long term data and implications for climate change

SKILLS TO BE LEARNED

- Analysis of atmospheric data
- Computer based simulation of atmospheric data

LIST OF EXPERIMENTS

Scilab/C++ based simulations experiments based on Atmospheric Physics problems like

1. Numerical Simulation for atmospheric waves using dispersion relations
2. Atmospheric gravity waves (AGW)
3. Kelvin waves
4. Rossby waves, and mountain waves
5. Offline and online processing of radar data
   a. VHF radar,
   b. X-band radar, and
   c. UHF radar
6. Offline and online processing of LIDAR data
7. Radiosonde data and its interpretation in terms of atmospheric parameters using vertical profiles

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in different regions of the globe.

8. Handling of satellite data and plotting of atmospheric parameters using radio occultation technique
9. Time series analysis of temperature using long term data over metropolitan cities in India – an approach to understand the climate change

TEXT BOOKS

1. Fundamental of Atmospheric Physics – Murry L Salby; Academic Press, Vol 61, 1996
2. The Physics of Atmosphere – J.T. Houghton; Cambridge Univ. Press; 3rd edn. 2002.

REFERENCE BOOKS

1. An Introduction to dynamic meteorology – James R Holton; Academic Press, 2004
2. Radar for meteorological and atmospheric observations – S Fukao and K Hamazu, Springer Japan, 2014

ASSESSMENT: MARKING SCHEME

Total Marks: 50

- **Internal assessment:** 10 marks
- **End term examination:** 40 marks (laboratory exam. will be conducted at the semester end).
  - Laboratory Notebook: 10 Marks
  - Experimental work and data analysis: 10 Marks
  - Presentation and Viva voce: 20 Marks

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PHY-DE-366 : NANO MATERIALS AND APPLICATIONS

Credit: 4 (L- 4:T- 0: P-0) Theory: (60 Lectures)

COURSE OBJECTIVES

The syllabus introduces the basic concepts and principles to understand nanomaterial. Various nanomaterial synthesis/growth methods and characterizations techniques are discussed to explore the field in detail. The effect of dimensional confinement of charge carries on the electrical, optical and structural properties are discussed. The concept of micro- and nano- electro mechanical systems (MEMS and NEMS) and important applications areas of nanomaterials are discussed.

COURSE LEARNING OUTCOME

At the end of the course the student is expected to possess the concept the following.

- In the Nano systems and its implications in modifying the properties of materials at the nanoscale.
- Concept of Quantum confinement, 3D,2D,1D and 0D nanostructure with examples.
- Different synthesis techniques including top down and bottom up approaches.
- Characterization of nanostructured materials using X-ray diffraction, electron microscopy, Atomic Force Microscopy and Scanning Tunneling Microscopy.
- Optical properties of nanostructured materials, modification of band gap, excitonic confinement.
- Applications of nanostructured materials in making devices namely MEMS, NEMS and other heterostructures for solar cell and LEDs.
- The student will synthesize nanoparticles by different chemical routs and characterize them in the laboratory using the different techniques he has learnt in the theory. He will also carry out thin film preparation and prepare capacitors and evaluate its performance. He also expected to fabricate a PN diode and study its I-V characteristics.

BROAD CONTENTS OF THE COURSE

- Nanoscale Systems
- Synthesis of Nanostructure Materials
- Characterization
- Optical Properties
- Electron Transport
- Applications

SKILLS TO BE LEARNED

- Develop basic understanding of nanostructured materials.
- Learn the synthesis and characterization of nanostructured materials.
- Understanding the optical properties of nanostructured materials and electron

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- Basics of electron transport phenomenon.
- transport phenomenon.
- Lean to understand the functioning of various analytical techniques using
- X-ray Diffraction
- Atomic Force Microscopy
- Scanning Electron Microscopy
- Scanning Tunneling Microscopy
- Transmission Electron Microscopy
- Application of nanoparticles in various fields like:
- LED
- Solar Cells
- Single Electron Transform Devices
- Magnetic Data Storage
- Micro-electrochemical Systems (MEMS)
- Nano- electrochemical Systems (NEMS)

DETAILED CONTENTS OF THE COURSE

MODULE 1

NANOSCALE SYSTEMS: Length scales in physics, Nanostructures: 1D, 2D and 3Dnanostructures (nanodots, thin films, nanowires, nanorods), Band structure and density of states of materials at nanoscale, Size Effects in nano systems, Quantum confinement: Applications of Schrodinger equation-Infinite potential well, potential step, potential box, quantum confinement of carriers in 3D, 2D, 1D nanostructures and its consequences. **(15 Lectures)**

MODULE 2

SYNTHESIS OF NANOSTRUCTURE MATERIALS: Top down and Bottom up approach, Photolithography. Ball milling. Gas phase condensation. Vacuum deposition. Physical vapor deposition (PVD): Thermal evaporation, E-beam evaporation, Pulsed Laser deposition. Chemical vapor deposition (CVD). Sol-Gel. Electro deposition. Spray pyrolysis. Hydrothermal synthesis. Preparation through colloidal methods. MBE growth of quantum dots. **(10 Lectures)**

CHARACTERIZATION: X-Ray Diffraction. Optical Microscopy. Scanning Electron Microscopy. Transmission Electron Microscopy. Atomic Force Microscopy. Scanning Tunneling Microscopy. **(5 Lectures)**

MODULE 3

OPTICAL PROPERTIES: Quasi-particles and excitons. Excitons in direct and indirect band gap semiconductor nanocrystals. Quantitative treatment of quasi- particles and excitons, charging effects.

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Radiative processes: General formalization-absorption, emission and luminescence. Optical properties of heterostructures and nanostructures. **(13 Lectures)**

ELECTRON TRANSPORT: Coulomb blockade effect, **(2 Lectures)**

MODULE 4

APPLICATIONS: Applications of nanoparticles, quantum dots, nanowires and thin films for photonic devices (LED, solar cells). Single electron transfer devices (no derivation). CNT based transistors. Nanomaterial Devices: Quantum dots heterostructure lasers, optical switching and optical data storage. Magnetic quantum well; magnetic dots - magnetic data storage. Micro Electromechanical Systems (MEMS), Nano Electromechanical Systems (NEMS). **(15 Lectures)**

TEXT BOOKS

1. C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.).
2. S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publishing Company)
3. K.K. Chattopadhyay and A. N. Banerjee, Introduction to Nanoscience and Technology (PHI Lear. Pvt. Ltd.)

REFERENCE BOOKS

1. Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).
2. M. Hosokawa, K. Nogi, M. Naita, T. Yokoyama, Nanoparticle Technology Handbook (Elsevier, 2007).
3. Introduction to Nanoelectronics, V.V. Mitin, V.A. Kochelap and M.A. Stroscio, 2011, Cambridge Univ.Press.
4. Bharat Bhushan, Springer Handbook of Nanotechnology (Springer-Verlag, Berlin, 2004).

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PHY-CC-366 (Practical) : NANO MATERIALS LABORATORY

Credit: 2 (L- 0:T- 0: P-2) Practical: 60 Hours

COURSE OBJECTIVES

The objective of this laboratory component is to give hand on experience in synthesis and characterization of nanostructures. Analysis of the characterization is also an objective of the course.

COURSE LEARNING OUTCOME

- To get the knowledge of development of nanomaterials
- To acquire an understanding basics of characterization techniques and analysis of data.

SKILLS TO BE LEARNED

- Development of nanomaterials
- Characterization of Nanomaterials

LIST OF EXPERIMENTS

1) Synthesis of metal nanoparticles by chemical route.
2) Synthesis of semiconductor nanoparticles.
3) Surface Plasmon study of metal nanoparticles by UV-Visible spectrophotometer.
4) XRD pattern of nanomaterials and estimation of particle size.
5) To study the effect of size on color of nanomaterials.
6) To prepare composite of CNTs with other materials.
7) Growth of quantum dots by thermal evaporation.
8) Prepare a disc of ceramic of a compound using ball milling, pressing and sintering, and study its XRD.
9) Fabricate a thin film of nanoparticles by spin coating (or chemical route) and study transmittance spectra in UV-Visible region.
10) Prepare a thin film capacitor and measure capacitance as a function of temperature or frequency.
11) Fabricate a PN diode by diffusing Al over the surface of N-type Si and study its V-I characteristic.

TEXT BOOKS

1. S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publishing Company).
2. K.K. Chattopadhyay and A.N. Banerjee, Introduction to Nanoscience & Technology (PHI Learn.).

REFERENCE BOOKS

3. C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.).
4. Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).

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ASSESSMENT: MARKING SCHEME

Total Marks: 50

- **Internal assessment:** 10 marks
- **End term examination:** 40 marks (laboratory exam. will be conducted at the semester end).
  - Laboratory Notebook: 10 Marks
  - Experimental work and data analysis: 10 Marks
  - Presentation and Viva voce: 20 Marks

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PHY-CC-367 : ASTRONOMY AND ASTROPHYSICS

Credit: 6 (L- 5:T- 0: P-0) Theory: 60 Lectures

COURSE OBJECTIVES

This course is designed to provide students with the basic knowledge about the theory and techniques of observational astronomy and physics of the astrophysical phenomenon. It applies theoretical concepts and mathematical techniques students have learnt in their earlier courses to astronomical and astrophysical phenomenon.

COURSE LEARNING OUTCOME

At the end of this course, students can comprehend astronomical scales and basic concepts of positional astronomy and can understand about stellar parameters and spectral classification. The basic knowledge of galaxies like their morphology and classifications and Milky Way can be acquired. Students can conceptualize about the large-scale structure and expanding universe and can understand astronomical techniques like mountings and operations along with various types of detectors and their uses. How to handle analytically and treat nonlinear problems in Astrophysical phenomena can be conceptualized using Software like Python etc.

BROAD CONTENTS OF THE COURSE

- Astronomy and astronomical measurement
- Steller spectra and Steller structure
- Galaxies and milky way
- Astronomical techniques

SKILLS TO BE LEARNED

- Mathematical know-how skills so as to enable to identify celestial positions, behaviors, measurements for clear cut ideas of Astronomy and Astrophysics.
- Skills needed to describe the properties of stars and especially observational data analysis skills using software in understanding astronomical phenomena.
- Ability to be acquired with the applications of statistical thermodynamics in the case of stellar spectral classifications and structures, even in the study of large-scale structure and expanding universe.
- Computational analysis and programming skills required for clear cut understanding of highly nonlinear astrophysical and astronomical systems like various galaxies.
- Highly appreciable skills and abilities in terms of the applications of Optics and Optical instruments to point at the celestial objects and to record the measuring parameters.

DETAILS CONTENTS OF THE COURSE

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MODULE 1

Positional Astronomy: Celestial Sphere, Geometry of a Sphere, Spherical Triangle, Geographical Coordinates, Horizon System, Equatorial System, Diurnal Motion of the Stars, Conversion of Coordinates, Sidereal Time, Apparent Solar Time, Mean Solar Time, Equation of Time, Calendar. **(7 Lectures)**

Astronomical measurements and Units: Geocentric parallax, annual parallax, 1AU, parsec, Light year(1Ly), radiant flux and luminosity, 1Jansky(1Jy), apparent and absolute magnitudes, distance modulus, determination of stellar temperature and radius, determination of orbital time and masses from binary system. **(8 Lectures)**

MODULE 2

Stellar spectral classification: Boltzmann and Saha equations for spectral lines, spectral types, surface temperature (spectral type) and luminosity (absolute magnitudes) relationship, Hertzsprung-Russell Diagram. **(7 Lectures)**

Stellar structure: Central pressure and temperature determination of a star, stellar energy and Virial theorem, Schwarschild instability condition, radiative gradient for a star, stellar evolution, Lane-Emden equation and polytropes. **(8 Lectures)**

MODULE 3

Galaxies: Galaxy morphology, Hubble's classification of Galaxies, Elliptical Galaxies, Spiral and Lenticular Galaxies (Bulges, Disks, Galactic Halo), Groups and Clusters of galaxies. **(8 Lectures)**

The Milky way: Basic Structure and Properties of the Milky Way, differential rotation of the Galaxy and Oort Constant, rotation curve of the Galaxy and the Dark Matter, Properties of and around the Galactic Nucleus. **(7 Lectures)**

MODULE 4

Large scale structure & expanding universe: Hubble's Law and scale factor, closed/open /flat universe, density parameter, age of the universe, dark energy and pressure. (6 Lectures)

Astronomical techniques: Basic optical definitions for Astronomy (Magnification Light Gathering Power, Resolving Power and Diffraction Limit), Optical telescopes (Types of Reflecting Telescopes, Telescope Mountings, Space Telescopes, Detectors and their uses with telescopes (Types of Detectors, detection Limits with Telescopes). **(9 Lectures)**

MODULE 5

Computational Astrophysics: Numerical solutions of algebraic equations, Numerical determination of Eigen values and Eigen vectors, Numerical integration, interpolation/extrapolation, Numerical differentiation, solutions of ordinary and partial differential equations, Fourier transform, (qualitative ideas only for N-Body Methods, Monte Carlo Method) (Tools like Python, MATLAB, Mathematica, Maple etc. as per requirements should be used as far as possible). **(15 Lectures)**

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TEXT BOOKS

1. Positional Astronomy, Derek McNally, TBS The Book Service Ltd (1 March 1975)
2. Textbook on Spherical Astronomy, W.M. Smart and R.M Green, Camb. Univ. Press; 6th ed.(1977)
3. Modern Astrophysics, B.W. Carroll & D.A. Ostlie, Addison-Wesley Publishing Co.

REFERENCE BOOKS

1. Classical Electrodynamics, J.D. Jackson, 3rd Edn., 1998, Wiley.
2. The Classical Theory of Fields, L.D Landau, E.M Lifshitz, 4th Edn., 2003, Elsevier.
3. Introduction to Electrodynamics, D.J. Griffiths, 2012, Pearson Education.
4. Classical Mechanics, R. Douglas Gregory, 2015, Cambridge University Press.
5. Classical Mechanics: An introduction, Dieter Strauch, 2009, Springer.
6. Solved Problems in classical Mechanics, O.L. Delange and J. Pierrus, 2010, Oxford Press

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PHY-DE-368 : DISSERTATION

Credit: 6 (L- 0:T- 0: P-6)

COURSE OBJECTIVES

Dissertation involves project work with the intention of exposing the student to research /development. It involves open ended learning based on student ability and initiative, exposure to scientific writing and inculcation of ethical practices in research and communication.

COURSE LEARNING OUTCOME

- Exposure to research methodology
- Picking up skills relevant to dissertation/project
- Development of creative ability and intellectual initiative
- Developing the ability for scientific writing
- Becoming conversant with ethical practices in acknowledging other sources, avoiding

SKILLS TO BE LEARNED

- Research and information literacy skills
- Intellectual /critical reasoning
- Problem solving and analysis
- Academic writing
- Presentation and Verbal communication

GUIDELINES FOR DISSSERTATION

1) The dissertation work should not be a routine experiment at the under graduate level. It should involve more than text book knowledge. Referring text books for preparation and understanding concepts is allowed.
2) Student may design and development of electronic circuits for practical applications using electronic components and microprocessor can also be considered as project.
3) The total number of students pursuing Project work/ Dissertation may be limited to 1/3rd of the total admitted students in the core discipline decided on the basis of their performance (Sincerity, academic performance and laboratory proficiency) .
4) Student is supposed to maintain a "Log Book" to summarize his/ her weekly progress which shall be duly signed by the supervisor. Experimental work should be carried out in the parent college.
5) It must have minimum three chapters namely (1) Introduction, (2) the main work including derivations / experimentation and Results, and (3) Discussion and Conclusion. At the end, adequate references must be included. Plagiarism should be avoided by the student and this should be checked by the supervisor.
6) For the interest of the students it is advised that college may organize a workshop for creating awareness amongst students about the Project work/Dissertation and its importance.

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PHY-DE-369: LABORATORY PHYSICS

Credit: 6 (L- 0:T- 0: P-6)

COURSE OBJECTIVES

The aim of this course is to exposing the student into deeper level in various laboratory experiments in Physics.

COURSE LEARNING OUTCOME

- Exposure to physics experiments into deeper level
- Skill to modify and rearrange of laboratory experiments
- Development of creative ability and intellectual initiative
- Enhancing the ability for laboratory report writing.
- Becoming conversant with ethical practices in acknowledging other sources,
- Avoiding plagiarism

SKILLS TO BE LEARNED

- Better skill to arrange experiment and data collection
- Academic writing
- Presentation and Verbal communication

GUIDELINES FOR REPORT

1) In this course, student will go through 'a set of 10 experiments' performed in the earlier semesters decided by the Department.
2) The set of 10 Experiments will be different for different students.
3) Students are encouraged to modify the way of performing the experiments based on their creativity. They can also use books and web resources to upgrade and modify the experiments.
4) Each student has to submit their monthly progress report to the department.
5) They have to prepare a report completing experimental methods, data analysis and discussion and have to submit to the department before the End term examination.
6) The student has to present his work in presentation his work in the end term examination.

ASSESSMENT OF DISERTATION: MARKING SCHEME:

- 20 marks: Internal assessment.
- 40 marks: Written Report.
- 40 marks: Presentation and Viva-voce

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PHY-SE-001 : BASICS OF ELECTRONIC CIRCUITS

Credit: 1 (L- 1:T- 0: P-0) Theory: 15 Lectures

COURSE OBJECTIVES

The aim of this course is to enable the students from area background to understand the basics of electronic circuits. Practical design and trouble shoot of electronic instrument is also a major objective of this Couse.

COURSE LEARNING OUTCOME

- After the completion of the course the student will acquire necessary skills/ hands on experience /working knowledge on multimeters, voltmeters, ammeters, electric circuit elements, dc power sources.
- With the knowledge of basic electronics and practical use of the measuring instruments, a student can able to troubleshoot and repair some of the electronic instruments used in our daily life.

BROAD CONTENS OF THE COURSE

- Basic principles of electronics
- Different types of Circuit elements
- electrical circuits and electrical drawings.
- Solid state devices and their uses.

SKILLS TO BE LEARNED

- Skills to use various types of instruments used for troubleshooting of electronic devices.
- Skills to understand various types of DC and AC circuits and making electrical drawings with symbols for various systems.
- Develop knowledge of solid-state devices and their uses.

DETAILS CONTENTS OF THE COURSE

Basic Electricity Principles: Voltage, Current, Resistance, and Power. Ohm's law. Series, parallel, and series-parallel combinations. AC Electricity and DC Electricity. Familiarization with multimeter, voltmeter and ammeter. **(3 Lectures)**

Understanding Electrical Circuits: Main electric circuit elements and their combination. Rules to analyze DC sourced electrical circuits. Current and voltage drop across the DC circuit elements. Single-phase and three-phase alternating current sources. Rules to analyze AC sourced electrical circuits. Real, imaginary and complex power components of AC source. Power factor. Saving energy and money. **(4 Lectures)**

Electrical Drawing and Symbols: Drawing symbols. Blueprints. Reading Schematics. Ladder diagrams. Electrical Schematics. Power circuits. Control circuits. Reading of circuit schematics. Tracking the connections of elements and identify current flow and voltage drop. **(4 Lectures)**

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Solid-State Devices: Resistors, inductors and capacitors. Diode and rectifiers. Components in Series or in shunt. Response of inductors and capacitors with DC or AC sources **(4 Lectures)**

TEXT BOOKS

1. A text book in Electrical Technology - B L Theraja - S Chand & Co.

REFERENCE BOOKS

2. A text book of Electrical Technology - A K Theraja
3. Performance and design of AC machines - M G Say ELBS Edn.

PHY-SE-001 (Practical) : ELECTRONIC CIRCUIT LABOATORY

Credit: 1 (L- 0:T- 0: P-1) Practical: 30 Hours

LABORATORY OBJECTIVES

- Skills to use various types of instruments used for troubleshooting of electronic devices.
- Laboratory report preparation

DETAILS OF LABOATORY WORKS

Sessions on the construction and use of specific measurement instruments and experimental apparatuses used in the physics lab, including necessary precautions. Sessions on the review of experimental data analysis and its application to the specific experiments done in the lab.

Part 1: Laboratory skill:

1) Identification of electronic component and measurement of their ratings.
2) Skill to use breadboard, hood up wire, laboratory experiment.
3) Skill to use multimeter for measuring resistance, voltage, current etc.
4) Identification of defecting component using multimeter.
5) Skill of soldering in Printed circuit board.

Part 2: Experiment:

1) Verification of ohm's law
2) Verification of Kirchhoff's law.
3) Verification of series and parallel combination formula of resistances.
4) Verification of formula for voltage divider theorem
5) Verification of formula for current divider theorem
6) Study of diode characteristics.
7) Construction of AC to DC power supply

Student have to prepare a notebook with all laboratory experiment performed in the semester and have to submitted to the department before examination.

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REFERENCE BOOKS

1. A text book in Electrical Technology - B L Theraja - S Chand & Co.
2. A text book of Electrical Technology - A K Theraja
3. Performance and design of AC machines - M G Say ELBS Edn.

ASSESSMENT: MARKING SCHEME

- **Internal assessment:** 10 marks
- **End term examination:** 40 marks
    - Laboratory Notebook: 10 Marks
    - Experimental work and data analysis: 10 Marks
    - Presentation and Viva voce: 20 Marks

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PHY-SE-003 : RENEWABLE ENERGY AND ENERGY HARVESTING

Credit: 1 (L- 1:T- 0: P-0) Theory: 15 Lectures

COURSE OBJECTIVES

To impart knowledge and hands on learning about various alternate energy sources to teach the ways of harvesting energy using wind, solar, mechanical, ocean, geothermal energy etc. To review the working of various energy harvesting systems which are installed worldwide.

COURSE LEARNING OUTCOME

- The students are expected to learn not only the theories of the renewable sources of energy, but also to have hands-on experiences on them wherever possible. Some of the renewable sources of energy which should be studied here are: (i) off-shore wind energy, (ii) tidal energy, (iii) solar energy, (iv) biogas energy and (v) hydroelectricity.
- All these energy sources should be studied in detail.
- Learn about piezoelectricity, carbon- captured technologies like cells, batteries.
- The students should observe practical demonstrations of (i) training modules of solar energy, wind energy etc., (ii) Conversion of vibration into voltage using piezoelectric materials, (iv) conversion of thermal energy into voltage using thermoelectric modules.

BROAD CONTENS OF THE COURSE

- Fossil fuels and Alternate Sources of Energy
- Solar energy
- Wind Energy harvesting
- Ocean Energy
- Geothermal Energy
- Hydro Energy
- Piezoelectric Energy Harvesting
- Electromagnetic Energy Harvesting

SKILLS TO BE LEARNED

- In this course student will study non –conventional energy sources and their practical applications.

DETAILS CONTENTS OF THE COURSE

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 non-conventional energy. **(3 Lectures)**

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Solar energy: Solar energy, its importance, storage of solar energy, solar pond, non-convective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning. **(5 Lectures)**

Wind Energy harvesting: Fundamentals of Wind energy, Wind Turbines- its construction. Power electronic interfaces, and grid interconnection topologies. **(2 Lectures)**

Hydro Energy: Hydropower resources, hydropower technologies, environmental impact of hydro power sources. **(2 Lectures)**

Ocean Energy: Ocean Energy Potential against Wind and Solar, Wave Energy Devices. Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass. **(2 Lectures)**

Geothermal Energy: Geothermal Resources and Technologies. **(1 Lectures)**

TEXT 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.

REFERENCE BOOKS

1. Godfrey Boyle, “Renewable Energy, Power for a sustainable future”, 2004, Oxford Univ. Press,
2. Dr. P Jayakumar, Solar Energy: Resource Assesment Handbook, 2009
3. J.Balfour, M.Shaw and S. Jarosek, Photovoltaics, Lawrence J Goodrich (USA).
4. http://en.wikipedia.org/wiki/Renewable_energy

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PHY-SE-003 (Practical) : PROJECT ON RENEWABLE ENERGY

Credit: 1 (L- 0:T- 0: P-1) Practical: 30 Hours

PROJECT OBJECTIVES

The objective project in this course is to enhance the knowledge and skill on some particular topic related to the course. It also provides technical knowledge to the student on various energy generation method.

GUIDELINES FOR PROJECT WORK

1) It may be a study report on particular topic, issue or experimental work linked to renewable energy and energy harvesting.
2) Student can design and development of mechanical device or electronic circuits which can be used for renewable energy generation.
3) Student have to submit a dissertation report on his/her work. The report should be of around 20 pages and must have minimum three chapters namely (1) Introduction, (2) the main work including derivations / experimentation and Results, and (3) Discussion and Conclusion. At the end, adequate references must be included. Plagiarism should be avoided by the student and this should be checked by the supervisor.
4) The evaluation/presentation/viva voce is done in the end semester examination.

ASSESSMENT OF PROJECT WORK: MARKING SCHEME

- **Internal assessment:** 10 marks
- **End term examination:** 40 marks
    - Project Report: 20 Marks
    - Presentation and Viva voce: 20 Marks

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PHY-SE-005 : SCIENTIFIC WRITING THROUGH LATEX

Credit: 1 (L- 1:T- 0: P-0) Theory: 15 Lectures

COURSE OBJECTIVES

This course provides students with an introduction to technical writing, complex graphics, and computer presentations with LATEX, which is the de-facto standard in Physics as well as other areas

COURSE LEARNING OUTCOME

Student will able to

- Handle different types of documents
- Organize documents into different sections, subsections, etc.
- Formatting pages (margins, header, footer, orientation)
- Formatting text
- Write complex mathematical formulae
- Include tables and images
- Cross-referencing, bibliography, and Indexing
- Read error messages as and when required
- Create presentations using Beamer

BROAD CONTENS OF THE COURSE

- Latex installation
- Basic document preparation and formatting
- Use of mathematical script in documents
- Formatting of table and images
- Referencing and indexing in document

SKILLS TO BE LEARNED

- Skill to prepare official document to dissertation using Latex
- Skill to prepare presentations

DETAILS CONTENTS OF THE COURSE

Introduction: History of LaTeX and its installation, different IDEs. How to create a document in LaTex, understanding Latex compilation. How to organize content into sections using article and book class of Latex. **(3 Lecturer)**

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Styling Pages: Review of different paper sizes, examines packages, formats the page by setting margins, customizing header and footer, changing the page orientation, dividing the document into multiple columns. The topic ends with reading different types of error messages. **(4 Lecturer)**

Formatting Content: Formatting text (styles, size, alignment), adding colors to text and entire page, and adding bullets and numbered items. It concludes by explaining the process of writing complex mathematics. **(3 Lecturer)**

Tables and Images: Creating basic tables, adding simple and dashed borders, merging rows and columns, and handling situations where a table exceeds the size of a page. The sessions then continue to add an image, explore different properties like rotate, scale, etc. **(3 lecturer)**

Referencing and Indexing: Adding cross-referencing (refer to sections, table, images), add bibliography (references), and create back index. **(1 Lecturer)**

Presentation using Beamer: Introduction to creating slides, adding frames, dividing the slide into multiple columns, adding different blocks, etc. **(1 Lecturer)**

TEXT BOOKS

1. LaTeX: A document preparation system, User's guide and reference manual by Leslie Lamport
2. LaTeX for Complete Novices by Nicola L. C. Talbot

REFERENCES

1. https://www.tug.org/twg/mactex/tutorials/ltxprimer-1.0.pdf
2. The LaTeX Companion by Frank Mittelbach, Michel Goossens, Johannes Braams, David Carlisle, Chris Rowley

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PHY-SE-005 (Practical) : PROJECT ON LATEX

Credit: 1 (L- 0:T- 0: P-1)

Practical: 30 Hours

LABORATORY OBJETIVES

To learn the practical use of Latex.

DETAILS OF PROJECT WORKS

Student have to use Latex to

1) Prepare a Lecture note on a particular topic of Physics
2) Prepare a presentation on a particular topic of Physics
3) Prepare a report on a particular research area using Latex with sections - (1) Literature survey (2) Formulation of objectives (3) Formulation of hypothesis/design/methodology (4) Formulation of work plan (5) Fund estimation (6) Conclusion

ASSESSMENT OF PROJECT WORK: MARKING SCHEME

- **Internal assessment:** 10 marks
- **End term examination:** 40 marks
    - Project Report: 20 Marks
    - Presentation and Viva voce: 20 Marks

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PHY-SE-002 : SPACE PHYSICS

Credit: 1 (L- 1:T- 0: P-0) Theory: 15 Lectures

COURSE OBJECTIVES

- To present the history and the importance of Space Science
- To familiarize with the pioneers of scientifically minded space observers.
- To impart knowledge on sun, moon and star of universe and their evaluation.
- To review various telescopes used for observation and research

COURSE LEARNING OUTCOME

Student will able to

- get a brief overview about our atmosphere and universe
- Learn about various techniques used for astronomical study

SKILLS TO BE LEARNED

- Skill to understand and explain night sky
- Able to explain different events in our solar system

DETAILS CONTENTS OF THE COURSE

A Brief History of Space Science, Pioneers of cosmic observers: Nicolaus Copernicus, Johannes Kepler, Galileo Galilei, Edwin Hubble etc. Importance of Space exploration, Contribution of India in space Exploration. **(2 lecture)**

Solar system: The sun-physical and orbital data - Photosphere - Chromosphere - corona - solar prominences - sunspot - sunspot cycle - theory of sunspots - solar flare -mass of the sun - solar constant - temperature of the sun - source of solar energy - solar wind. Other members of the solar system - Mercury - Venus - Earth - Mars - Jupiter - Saturn - Uranus - Neptune - Pluto - Moon - Bode's law - Asteroids - comets - Meteors. **(4 lecture)**

Universe: Stellar Evolution, elementary idea about birth and death of star, Chandrasekar limit, Neutron star, black hole, Theories of the universe, galaxies and star clusters Origin of the universe - the big bang theory Hubble's law. Galaxies - types of galaxies - Milky Way - star clusters - open clusters - globular Clusters **(4 lecturer)**

Astronomical instruments: Optical telescope - reflecting telescope - types of reflecting telescope - advantages of reflecting telescope - Radio telescopes - astronomical spectrographs **(5 lecture)**

TEXT BOOKS

1. Astrophysics for people in a hurry – Neil de Grasse Tyson
2. Astronomy 101 – Carolyn Collins Peterson

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REFERENCE BOOKS

3. Cosmos –Carl Sagan
4. A Brief History of Time – Stephen Hawking
5. ISRO A personal History- R. Aravamudan
6. Non-conventional energy sources - G.D Rai - Khanna Publishers, New Delhi
7. Solar energy - M P Agarwal - S Chand and Co. Ltd.
8. Solar energy - Suhas P Sukhative Tata McGraw - Hill Publishing Company Ltd.
9. Godfrey Boyle, "Renewable Energy, Power for a sustainable future", 2004, Oxford University Press, in association with The Open University.
10. Dr. P Jayakumar, Solar Energy: Resource Assesment Handbook, 2009
11. J.Balfour, M.Shaw and S. Jarosek, Photovoltaics, Lawrence J Goodrich (USA).
12. http://en.wikipedia.org/wiki/Renewable_energy

PHY-SE-002 (Practical) : PROJECT ON SPACE PHYSICS

Credit: 1 (L- 0:T- 0: P-1) Practical: 30 Hours

PROJECT OBJECTIVES

The objective project in this course is to enhance the knowledge and skill on some particular topic related to space and universe.

GUIDELINES FOR PROJECT WORK

1) It may be a study report on particular topic, issue or experimental work related to Astrophysics.
2) Student can design and development of mechanical device or experimental setup to study a particular phenomenon related to space physics.
3) Student have to submit a dissertation report on his/her work. The report should be of around 20 pages and must have minimum three chapters namely (1) Introduction, (2) the main work including derivations / experimentation and Results, and (3) Discussion and Conclusion. At the end, adequate references must be included. Plagiarism should be avoided by the student and this should be checked by the supervisor.
4) The evaluation/presentation/viva voce is done in the end semester examination.

ASSESSMENT OF PROJECT WORK: MARKING SCHEME

- **Internal assessment:** 10 marks
- **End term examination:** 40 marks
  - Project Report: 20 Marks
  - Presentation and Viva voce: 20 Marks

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PHY-SE-004 : ELECTRONICS IN EVERYDAY LIFE

Credit: 1 (L- 1:T- 0: P-0) Theory: 15 Lectures

COURSE OBJECTIVES

- This course is basically treated to explain the basics of Altering current and its generation as well as distribution. The course also aims to enlighten the fundamental of various electrical devices used in our daily life.

COURSE LEARNING OUTCOME

- To understand the basic concept of AC voltage and current
- Generation of AC current and its distribution
- AC electrical wire (220 V line) at home and laboratory.
- Various components used in electrical distribution.
- Different types of electrical appliances and its working.

SKILLS TO BE LEARNED

- Basics of AC current generation and distribution
- Skills of household wiring
- Different power backup systems.
- Principles and techniques of electrical items used at home
- Electrical wiring and measures for electrical protection.
- Physics of generators, transformers, electric motors

DETAILS CONTENTS OF THE COURSE

Basics of electricity: Electrical charge, Current and voltage, resistance, inductance, capacitance. DC Power supply- batteries. AC currents – single phase and three phase, RMS and peak value. Power stations. Basics of Generators and Transformers, Distribution of electricity to factory, college and to home. **(2 lectures)**

Electrical Wiring: Conductors and cables – its types, Basics of wiring. Voltage drop and losses across cables and conductors. Instruments to measure current, voltage, power in DC and AC circuits. Insulation. Solid and stranded cable. Conduit. Cable trays. Splices: wire nuts, crimps, terminal blocks, split bolts, and solder. Preparation of extension board. **(4 Lectures)**

Electrical Protection: Relays. Fuses and disconnect switches. Circuit breakers. Overload devices. Ground-fault protection. Grounding and isolating. Phase reversal. Surge protection. **(2 Lectures)**

Alternative power source: Inverter and UPS, online UPS and offline UPS, Solar inverter, Grid connection of solar energy. **(2 Lectures)**

Electric Motors: Single-phase, three-phase & DC motors. Basic principle and construction. Speed & power of ac moto, motor based electronic appliances- fan, mixer grinder, electronic vehicles. **(3 Lectures)**

Electrical bulbs - Fluorescent lamps - street lighting - flood lighting water heater - storage and instant types, electric iron box, microwave oven - Stabilizer, fridge. **(2 Lectures)**

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TEXT BOOKS

1. Home Electrical Wiring: A Complete Guide to Home Electrical Wiring by by David W Rongey

REFERENCES

1. https://www.electrical4u.com
2. Electric Wiring: Domestic 13th Edition

PHY-SE-004 (Practical) : PROJECT ON ELECTRONIC APPLIANCES

Credit: 1 (L- 0:T- 0: P-1) Practical: 30 Hours

PROJECT OBJECTIVES

The objective project in this course is to enhance skill on some electrical items used in our daily life.

GUIDELINES FOR PROJECT WORK

In the dissertation work, student have to submit a report on their work related to various electronic items used in our day to day life such as

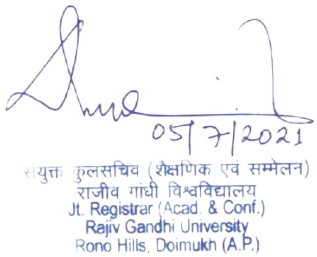
- Identification of various types of batteries
- Testing of the quality different types of wire in terms of insulation and material
- Testing of various type of circuit breaker used in household wiring
- Construction of extension board
- UPS/ Inverter troubleshooting
- Disassembling LED bulb Etc.

In the report, student has to explain the work did for each experiment in sections - (i) Experimental work (ii) Used Items with Model No, Serial No. and specifications) (iIi) Experimental work performed. (iv) skill Learned from the experiment and (v) Conclusion

The evaluation/presentation/viva voce is to be done in the end semester examination.

ASSESSMENT OF PROJECT WORK: MARKING SCHEME

- **Internal assessment:** 10 marks
- **End term examination:** 40 marks
  - Project Report: 20 Marks
  - Presentation and Viva voce: 20 Marks



PHY-SE-006 : ELECTRIC AND HYBRID VEHICLES

Credit: 1 (L- 1:T- 0: P-0) Theory: 15 Lectures

COURSE OBJECTIVES

The aim of this course is to provide a basic idea about the physics behind the electric vehicles.

COURSE LEARNING OUTCOME

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

- To understand the basics of electric and hybrid electric vehicles and their working.
- To understand the basics of batteries and their role for electric/hybrid vehicle applications.
- To obtain the knowledge of various types of electric/hybrid vehicles.
- To understand the real time challenges in the implementation of this technology

SKILLS TO BE LEARNED

- Working principles of electronic and hybrid vehicles.
- Use of generators, transformers, electric motors used in electronic vehicles

DETAILS CONTENTS OF THE COURSE

History of electronic vehicles (EV), comparison with the internal combustion engine, Introduction to electric and hybrid vehicles: Hybrid vehicle architectures, Series hybrid vehicle architectures- range extender and full hybrid systems, Parallel hybrid architectures, Plug-in hybrid architectures, Commercially available electric and hybrid vehicles **(4 Lecturer)**

Propulsion System in EV, Basic Mechanics of a Vehicle, Energy consumed in a vehicle, Powertrain component sizing, Transmission configuration, components- electric motor, gears, brakes, regenerative braking. **(3 Lecturer)**

Driving cycles, Energy requirements, City cycle, highway cycle, and combined cycle (2 Lecturer) Fuel cell vehicles, Electric Motor Drive systems for EV/HEVs, Power Electronic converters for electric and hybrid vehicles. **(3 Lecturer)**

Energy Storage and management in EV: Battery energy storage-types of battery, Battery charging and range – types of charging technology, fast charging, supercapacitor and ultracapacitors, Energy management and control strategies, Hybrid vehicle control strategies **(3 lecturer)**

Benefits of owing an EV, various Govt. schemes and incentives, EVs on Indian roads, Challenges for EVs, Future of EVs **(2 Lecturer)**

TEXT BOOKS

Electric Vehicle Technology Explained by, Larminie James

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REFERENCE

1. https://en.wikipedia.org/wiki/Electric_vehicle
2. https://electrek.co/
3. https://electricvehicleweb.in/

PHY-SE-006 (Practical) : PROJECT ON ELECTRONIC VEHICLES

Credit: 1 (L- 1:T- 0: P-0) Practical: 30 Hours

OBJECTIVES

To enhance the in-depth knowledge of electronic vehicle available in market.

DETAILS OF PROJECT WORK

Each student enrolled in the course have to submit this project report on a particular model of EV available in the market. In the report he/she have to mention the working principle, each component of the vehicle, advantages, disadvantages and his/her comets on the model.

ASSESSMENT OF PROJECT WORK: MARKING SCHEME

- **Internal assessment:** 10 marks
- **End term examination:** 40 marks
    - Project Report: 20 Marks
    - Presentation and Viva voce: 20 Marks

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PHY-GE-001 : MECHANICS

Credit: 4 (L- 4:T- 0: P-0) Theory: 60 Lectures

Students are not familiar with vector calculus. Hence all examples involve differentiation either in one dimension or with respect to the radial coordinate

COURSE OBJECTIVES

This course begins with the review of Vectors and Differential equations and ends with the Special Theory of Relativity. Students will also appreciate the Gravitation, Rotational Motion and Oscillations. The emphasis of this course is to enhance the basics of mechanics.

COURSE LEARNING OUTCOME

After going through the course, the student should be able to

- Understand the role of vectors and coordinate systems in Physics.
- Write the expression for the moment of inertia about the given axis of symmetry for different uniform mass distributions.
- Explain the conservation of energy, momentum, angular momentum and apply them to basic problems.
- Understand the analogy between translational and rotational dynamics, and application of both motions simultaneously in analyzing rolling with slipping.
- Apply Kepler's law to describe the motion of planets and satellite in circular orbit.
- Explain the phenomena of simple harmonic motion and the properties of systems executing such motions.
- Describe how fictitious forces arise in a non-inertial frame, e.g., why a person sitting in a merry-go-round experiences an outward pull.
- Describe special relativistic effects and their effects on the mass and energy of a moving object.
- In the laboratory course, after acquiring knowledge of how to handle measuring instruments (like screw gauge, Vernier callipers, Travelling microscope) student shall embark on verifying various principles learnt in theory. Measuring 'g' using Bar Pendulum, Kater pendulum and measuring elastic constants of materials, viscous properties of liquids etc.

BROAD CONTENTS OF THE COURSE

- Vectors
- Ordinary Differential Equations
- Laws of Motion
- Momentum and Energy
- Rotational Motion
- Gravitation
- Oscillations

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- Elasticity
- Special Theory of Relativity

SKILLS TO BE LEARNED

- Learn basic mathematics like vectors and ordinary different equation and to understand linear and rotational motion.
- Learn basics of Newtonian gravitation theory and central force problem.
- Learn basic ideas about mechanical oscillators.
- Learn elasticity and elastic constants of material and perform experiments to study them.
- Acquire basic knowledge of special theory of relativity.

DETAILED CONTENTS OF THE COURSE

MODULE 1

Vectors: Vector algebra. Scalar and vector products. Derivatives of a vector with respect to a parameter. **(4 Lectures)**

Ordinary Differential Equations: 1st order homogeneous differential equations. 2nd order homogeneous differential equations with constant coefficients. **(6 Lectures)**

MODULE 2

Laws of Motion: Frames of reference. Newton's Laws of motion. Dynamics of a system of particles. Centre of Mass. **(5 Lectures)**

Momentum and Energy: Conservation of momentum. Work and energy. Conservation of energy. Motion of rockets. **(5 Lectures)**

Rotational Motion: Angular velocity and angular momentum. Torque. Conservation of angular momentum. **(5 Lectures)**

MODULE 3

Gravitation: Newton's Law of Gravitation. Motion of a particle in a central force field (motion is in a plane, angular momentum is conserved, areal velocity is constant). Kepler's Laws (statement only). Satellite in circular orbit and applications. Geosynchronous orbits. Basic idea of global positioning system (GPS). Weightlessness. Physiological effects on astronauts. **(7 Lectures)**

Elasticity: Hooke's law - Stress-strain diagram - Elastic moduli-Relation between elastic constants - Poisson's Ratio-Expression for Poisson's ratio in terms of elastic constants - Work done in stretching and work done in twisting a wire - Twisting couple on a cylinder - Determination of Rigidity modulus by static torsion – Torsional pendulum-Determination of Rigidity modulus and moment of inertia - q, η and γ by Searles method. **(8 Lectures)**

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MODULE 4

Fluids: Surface Tension, Synclastic and anticlastic surface - Excess of pressure -Application to spherical and cylindrical drops and bubbles - variation of surface tension with temperature - Jaegar's method. Viscosity - Rate flow of liquid in a capillary tube - Poiseuille's formula - Determination of coefficient of viscosity of a liquid - Variations of viscosity of liquid with temperature- lubrication. **(10 Lectures)**

Special Theory of Relativity: Constancy of speed of light. Postulates of Special Theory of Relativity. Length contraction. Time dilation. Relativistic addition of velocities. . (5 Lectures)

TEXT BOOKS

1. University Physics. F.W. Sears, M.W. Zemansky and H.D. Young, 13/e, 1986. Addison- Wesley
2. Mechanics Berkeley Physics, v.1: Charles Kittel, et. al. 2007, Tata McGraw-Hill.

REFERENCE BOOKS

1. Physics – Resnick, Halliday & Walker 9/e, 2010, Wiley
2. Engineering Mechanics, Basudeb Bhattacharya, 2nd edn., 2015, Oxford University Press
3. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

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Rono Hills, Doimukh (A.P.)

PHY-GE-001(Practical): GENERIC PHYSICS LABORATORY I

Credit: 2 (L- 0:T- 0: P-2)

Practical: 60 Hours

COURSE OBJETIVES

The aim of this laboratory component is to provide skills on different measurement techniques generally used by science students. However, to enhance their knowledge on some basic physics phenomena mechanics, some very fundamental experiments is to be performed in the laboratory.

COURSE LEARNING OUTCOME

Though the laboratory works a student will learn

- The construction and use of Vernier calipers, screw gauge and travelling microscope, and necessary precautions during their use.
- Techniques to determine least count errors, their propagation and recording in final result up to correct significant digits
- Linearization of data and the use of slope and intercept to determine unknown quantities
- scientific laboratory reports, which may include theoretical and practical significance of the experiment performed, apparatus description, relevant theory, necessary precautions to be taken during the experiment, proper recording of observations, data analysis, estimation of the error and explanation of its sources, correct recording of the result of the experiment, and proper referencing of the material taken from other sources (books, websites, research papers, etc.).

SKILLS TO BE LEARNED

- To use of various measuring instruments used in any science laboratory.
- Skill to use of graph between two different physical quantities to calculate an unknown quantity.
- Art of scientific report wringing of laboratory work.

DETAILED CONTENTS OF THE COURSE

1. Measurements of length (or diameter) using vernier caliper, screw gauge and travelling microscope.
2. To determine the Height of a Building using a Sextant.
3. To determine the Moment of Inertia of a Flywheel.
4. To determine the Young's Modulus of a Wire by Optical Lever Method.
5. To determine the Modulus of Rigidity of a Wire by Maxwell’s needle.
6. To determine the Elastic Constants of a Wire by Searle’s method.
7. To determine g by Bar Pendulum.
8. To determine g by Kater’s Pendulum.
9. To study the Motion of a Spring and calculate (a) Spring Constant, (b) g.

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TEXT BOOKS

1. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Ed. 2011, Kitab Mahal, New Delhi

REFERENCE BOOKS

1. Engineering Practical Physics, S. Panigrahi & B.Mallick, 2015, Cengage Learning India Pvt. Ltd.
2. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Pub. House..
3. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Ed Heinemann Educational Publishers

ASSESSMENT: MARKING SCHEME

Total Marks: 50

- **Internal assessment:** 10 marks)
- **End term examination:** 40 (laboratory examination will be conducted at the semester end)
  - Laboratory Notebook: 10 Marks
  - Experimental work and data analysis: 10 Marks
  - Presentation and Viva voce: 20 Marks

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PHY-GE-002 : ELECTRICITY AND MAGNETISM

Credit: 4 (L- 4:T- 0: P-0)

Theory: 60 Lectures

COURSE OBJECTIVES

This course begins with elementary vector analysis, an essential mathematical tool for understanding static electric field and magnetic field. By the end of the course student should appreciate Maxwell's equations

COURSE LEARNING OUTCOME

After going through the course, the student should be able to

- Demonstrate Coulomb's law for the electric field, and apply it to systems of point charges as well as line, surface, and volume distributions of charges.
- Explain and differentiate the vector (electric fields, Coulomb's law) and scalar (electric potential, electric potential energy) formalisms of electrostatics.
- Apply Gauss's law of electrostatics to solve a variety of problems.
- Articulate knowledge of electric current, resistance and capacitance in terms of electric field and electric potential.
- Demonstrate a working understanding of capacitors.
- Describe the magnetic field produced by magnetic dipoles and electric currents.
- Explain Faraday-Lenz and Maxwell laws to articulate the relationship between electric and magnetic fields.
- Describe how magnetism is produced and list examples where its effects are observed.
- Apply Kirchhoff's rules to analyze AC circuits consisting of parallel and/or series combinations of voltage sources and resistors and to describe the graphical relationship of resistance, capacitor and inductor.
- Apply various network theorems such as Superposition Theorem, Thevenin Theorem, Norton Theorem, Reciprocity Theorem, Maximum Power Transfer, etc. and their applications in electronics, electrical circuit analysis, and electrical machines.
- In the laboratory course the student will get an opportunity to verify all the above-mentioned theorems elaborated above, using simple electric circuits.

BROAD CONTENTS OF THE COURSE

- Vector Analysis
- Electrostatistics
- Magnetism
- Electromagnetic Induction
- Maxwell's Equation and EM Wave propagation.

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SKILLS TO BE LEARNED

- This course will help in understanding basic concepts of electricity and magnetism and their applications.
- Basic course in electrostatics will equips the student with required prerequisites to understand electrodynamics phenomena.

DETAILED CONTENTS OF THE COURSE

MODULE 1

Vector Analysis: Review of vector algebra (Scalar and Vector product), gradient, divergence, Curl and their significance, Vector Integration, Line, surface and volume integrals of Vector fields, Gauss-divergence theorem and Stoke's theorem (statement only). **(15 Lectures)**

MODULE 2

Electrostatics: Electrostatic Field, electric flux, Gauss's theorem of electrostatics. Applications of Gauss theorem - Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor. Electric potential as line integral of electric field, potential due to a point charge, electric dipole, uniformly charged spherical shell and solid sphere. Calculation of electric field from potential. Capacitance of an isolated spherical conductor. Parallel plate, spherical and cylindrical condenser. Energy per unit volume in electrostatic field. **(15 Lectures)**

MODULE 3

Electrostatics in Dietetic medium: Dielectric medium, Polarization, Displacement vector. Gauss's theorem in dielectrics. Parallel plate capacitor filled with dielectric. **(5 Lectures)**

Magnetism: Magnetostatics: Biot-Savart's law and its applications- straight conductor, circular coil, solenoid carrying current. Divergence and curl of magnetic field. Magnetic vector potential. Ampere's circuital law. Magnetic properties of materials: Magnetic intensity, magnetic induction, permeability, magnetic susceptibility. Brief introduction of dia-, para-and ferro- magnetic materials. **(10 Lectures)**

MODULE 4

Electromagnetic Induction: Faraday's laws of electromagnetic induction, Lenz'slaw, self and mutual inductance, L of single coil, M of two coils. Energy stored in magnetic field. **(5 Lectures)**

Maxwell`s equations and Electromagnetic wave propagation: Equation of continuity of current, Displacement current, Maxwell's equations, Poynting vector, energy density in electromagnetic field, electromagnetic wave propagation through vacuum and isotropic dielectric medium, transverse nature of EM waves, polarization. **(10 Lectures)**

TEXT BOOKS

1. Electricity and Magnetism, Edward M. Purcell, 1986, McGraw-Hill Education

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

REFERENCE BOOKS

1. Electricity and Magnetism, D C Tayal, 1988, Himalaya Publishing House.
2. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
3. D.J.Griffiths, Introduction to Electrodynamics, 3rd Edn, 1998, Benjamin Cummings & Company

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PHY-GE-002 (Practical): GENERIC PHYSICS LABORATORY II

Credit: 2 (L- 0:T- 0: P-2)

Practical: 60 Hours

COURSE OBJETIVES

The aim of this laboratory components is to provide skills to use various types of instruments and techniques used measure electronic parameter (voltage, current etc.). Again, some other experiment will provide the practical understanding on some basic phenomena of electricity , magnetism and electronics..

COURSE LEARNING OUTCOME

- construction, functioning and uses of different electrical bridge circuits, and electrical devices like the ballistic galvanometer.
- review of scientific laboratory report writing, and on experimental data analysis, least square fitting, and computer programme to find slope and intercept of straight line graphs of experimental data.

SKILLS TO BE LEARNED

- To use of various measuring instruments related to electricity and magnetism
- Hand on experience on electrical circuits.
- Skill to use of graph between two different physical quantities to calculate an unknown quantity.
- Art of scientific report wringing of laboratory work.

DETAILED CONTENTS OF THE COURSE

1. To use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, and (d) checking electrical uses.
2. Ballistic Galvanometer:
    - Measurement of charge and current sensitivity
    - Measurement of CDR
    - Determine a high resistance by Leakage Method
    - To determine Self Inductance of a Coil by Rayleigh's Method.
3. To compare capacitances using De' Sauty's bridge.
4. Measurement of field strength B and its variation in a Solenoid (Determine dB/dx)
5. To study the Characteristics of a Series RC Circuit.
6. To study a series LCR circuit and determine its (a) Resonant frequency, (b) Quality factor
7. To study a parallel LCR circuit and determine its (a) Anti-resonant frequency and (b) Quality factor Q
8. To determine a Low Resistance by Carey Foster's Bridge.
9. To verify the Thevenin and Norton theorems
10. To verify the Superposition, and Maximum Power Transfer Theorems.

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TEXT BOOKS

1. Advanced Practical Physics for students, B.L.Flint & H.T.Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers

REFERENCE BOOKS

3. A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed.2011, Kitab Mahal
4. Engineering Practical Physics, S.Panigrahi & B.Mallick,2015, Cengage Learning India.

ASSESSMENT: MARKING SCHEME

Total Marks: 50

- **Internal assessment:** 10 marks
- **End term examination:** 40 (laboratory examination will be conducted at the semester end)
  - Laboratory Notebook: 10 Marks
  - Experimental work and data analysis: 10 Marks
  - Presentation and Viva voce: 20 Marks

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PHY-GE-003 : WAVE AND OPTICS

Credit: 4 (L- 4:T- 0: P-0) Theory: 60 Lectures

COURSE OBJECTIVES

This course reviews the concepts of waves and optics learnt at school from a more advanced perspective and goes on to build new concepts. It begins with explaining ideas of superposition of harmonic oscillations leading to physics of travelling and standing waves.

The course also provides an in depth understanding of wave phenomena of light, namely, interference and diffraction with emphasis on practical applications of the same

COURSE LEARNING OUTCOME

This course will enable the student to

- Recognize and use a mathematical oscillator equation and wave equation, and derive these equations for certain systems.
- Apply basic knowledge of principles and theories about the behavior of light and the physical environment to conduct experiments.
- Understand the principle of superposition of waves, so thus describe the formation of standing waves.
- Explain several phenomena we can observe in everyday life that can be explained as wave phenomena.
- Use the principles of wave motion and superposition to explain the Physics of polarisation, interference and diffraction.
- Understand the working of selected optical instruments like biprism, interferometer, diffraction grating, and holograms.
- In the laboratory course, student will gain hands-on experience of using various optical instruments and making finer measurements of wavelength of light using Newton Rings experiment, Fresnel Biprism etc. Resolving power of optical equipment can be learnt first hand.
- The motion of coupled oscillators, study of Lissajous figures and behavior of transverse, longitudinal waves can be learnt in this laboratory course.

BROAD CONTENTS OF THE COURSE

- Superposition of Two Collinear Harmonic Oscillations
- Superposition of Two Perpendicular Harmonic Oscillations
- Waves Motion – General
- Velocity of Waves
- Superposition of Two Harmonics Waves
- Wave Optics
- Interference

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- Michelson's Interferometer
- Diffraction
- Fraunhofer Diffraction
- Fresnel Diffraction
- Polarization

SKILLS TO BE LEARNED

- This course in basics of optics will enable the student to understand various optical phenomena, principles, workings and applications optical instruments
- He / she shall develop an understanding of Waves Motion and its properties.

DETAILED CONTENTS OF THE COURSE

MODULE 1

Oscillations: Simple harmonic motion. Differential equation of SHM and its solutions. Kinetic and Potential Energy, Total Energy and their time averages. Damped oscillations. **(8 Lectures)**

Superposition of Two Collinear Harmonic oscillations: Linearity & Superposition Principle. Oscillations having equal frequencies and (2) Oscillations having different frequencies (Beats). **(5 Lectures)**

Superposition of Two Perpendicular Harmonic Oscillations: Graphical and Analytical Methods. Lissajous Figures with equal an unequal frequency and their uses. **(2 Lectures)**

MODULE 2

Waves Motion- General: Transverse waves on a string. Travelling and standing waves on a string. Normal Modes of a string. Group velocity, Phase velocity. Plane waves. Spherical waves, Wave intensity. **(6 Lectures).**

Sound: Simple harmonic motion - forced vibrations and resonance - Fourier's Theorem - Application to saw tooth wave and square wave - Intensity and loudness of sound - Decibels - Intensity levels - musical notes - musical scale. Acoustics of buildings: Reverberation and time of reverberation - Absorption coefficient - Sabine's formula - measurement of reverberation time - Acoustic aspects of halls and auditoria. **(9 Lectures)**

MODULE 3

Wave Optics: Electromagnetic nature of light. Definition and Properties of wave front. Huygens Principle. **(2 Lectures)**

Interference: Division of amplitude and division of wavefront. Young's Double Slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal

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thickness (Fizeau Fringes). Newton's Rings: measurement of wavelength and refractive index. (12 Lectures)

Michelson's Interferometer: Idea of form of fringes (no theory needed), Determination of wavelength, Wavelength difference, Refractive index, and Visibility of fringes. **(3 Lectures)**

MODULE 4

Diffraction: Fraunhofer diffraction- Single slit; Double Slit. Multiple slits and Diffraction grating. Fresnel Diffraction: Half-period zones. Zone plate. Fresnel Diffraction pattern of a straight edge, a slit and a wire using half-period zone analysis. **(12 Lectures)**

Polarization: Transverse nature of light waves. Plane polarized light – production and analysis. Circular and elliptical polarization. **(3 Lectures)**

TEXT BOOKS

1. Principles of Optics, B.K. Mathur, 1995, Gopal Printing
2. Fundamentals of Optics, H.R. Gulati and D.R. Khanna, 1991, R. Chand Publications

REFERENCE BOOKS

3. Fundamentals of Optics, F.A Jenkins and H.E White, 1976, McGraw-Hill
4. University Physics. F.W. Sears, M.W. Zemansky and H.D. Young. 13/e, 1986. Addison- Wesley

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PHY-GE-003(Practical): GENERIC PHYSICS LABORATORY III

Credit: 2 (L- 0:T- 0: P-2) Practical: 60 Hours

COURSE OBJECTIVES

The main objective of this laboratory component is to understand the different phenomenon of optics through though laboratory experiments.

COURSE LEARNING OUTCOME

From various experiments in the course student will learn

- Use of spectrometer and lasers, and necessary precautions during the experiments.
- Sessions on the review of experimental data analysis, sources of error and their estimation in detail, writing of scientific laboratory reports including proper reporting of errors
- linearization of data and the use of slope and intercept to determine unknown quantities.
- How to present their experimental data in a laboratory report.

SKILLS TO BE LEARNED

- Hand on experience on various light sources and spectrometer.
- Arrangement of optics related experimental set-up
- Data analysis, error calculation and laboratory report preparation

DETAILED CONTENTS OF THE COURSE

1. To investigate the motion of coupled oscillators
2. To determine the Frequency of an Electrically Maintained Tuning Fork by Melde's Experiment and to verify λ^2 – T Law.
3. To study Lissajous Figures
4. Familiarization with Schuster`s focussing; determination of angle of prism.
5. To determine the Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
6. To determine the Refractive Index of the Material of a Prism using Sodium Light.
7. To determine Dispersive Power of the Material of a Prism using Mercury Light
8. To determine the value of Cauchy Constants.
9. To determine the Resolving Power of a Prism.
10. To determine wavelength of sodium light using Fresnel Biprism.
11. To determine wavelength of sodium light using Newton's Rings.
12. To determine the wavelength of Laser light using Diffraction of Single Slit.
13. To determine wavelength of (1) Sodium and (2) Spectral lines of the Mercury light using plane diffraction Gratin
14. To determine the Resolving Power of a Plane Diffraction Grating.
15. To measure the intensity using photosensor and laser in diffraction patterns of single and double slits.

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TEXT BOOKS

1. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.

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2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers

ASSESSMENT: MARKING SCHEME

Total Marks: 50

- **Internal assessment:** 10 marks
- **End term examination:** 40 (laboratory examination will be conducted at the semester end)
  - Laboratory Notebook: 10 Marks
  - Experimental work and data analysis: 10 Marks
  - Presentation and Viva voce: 20 Marks

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PHY-GE-004: THERMAL PHYSICS AND STATISTICAL MECHANICS

Credit: 4 (L- 4:T- 0: P-0) Theory: 60 Lectures

COURSE OBJECTIVES

This course will introduce Thermodynamics, Kinetic theory of gases and Statistical Mechanics to the students. Th primary goal is to understand the fundamental laws of thermodynamics and its applications to various thermo dynamical systems and processes. This coursework will also enable the students to understand the connection between the macroscopic observations of physical systems and microscopic behavior of atoms and molecule through statistical mechanics.

COURSE LEARNING OUTCOME

- Learn the basic concepts of thermodynamics, the first and the second law of thermodynamics, the concept of entropy and the associated theorems, the thermodynamic potentials and their physical interpretations. They are also expected to learn Maxwell's thermodynamic relations.
- Know the fundamentals of the kinetic theory of gases, Maxwell-Boltzman distribution law, equipartition of energies, mean free path of molecular collisions, viscosity, thermal conductivity, diffusion and Brownian motion.
- Have a knowledge of the real gas equations, Van der Waal equation of state, the Joule-Thompson effect.
- Learn about the black body radiations, Stefan- Boltzmann's law, Rayleigh-Jean's law and Planck's law and their significances.
- Learn the quantum statistical distributions, viz., the Bose-Einstein statistics and the Fermi-Dirac statistics.
- In the laboratory, the students are expected to perform the following experiments related to thermal conduction and radiation.

BROAD CONTENTS OF THE COURSE

- Laws of Thermodynamics
- Thermodynamic Potentials
- Kinetic Theory of Gases
- Theory of Radiation
- Introduction to Statistical Mechanics

SKILLS TO BE LEARNED

- In this course the students should skilled in doing calculations in thermodynamics and in statistical mechanics.
- They should also be proficient in doing calculations with the kinetic theory of ideal and real gases.

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- In the laboratory course, the students should acquire the skills of doing basic experiments in thermal physics with the right theoretical explanations of results there from.

DETAILED CONTENTS OF THE COURSE

MODULE 1

Introduction to thermodynamics: Thermodynamic Description of system: Zeroth Law of thermodynamics and temperature. First law and internal energy, conversion of heat into work, Various Thermodynamical Processes, Applications of First Law: General Relation between CP and CV, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Coefficient, Reversible and irreversible processes, Second law and Entropy, Carnot's cycle & theorem, **(15 lecture)**

MODULE 2

Entropy of thermodynamical system: Entropy changes in reversible & irreversible processes, Entropy-temperature diagrams, Third law of thermodynamics, Unattainability of absolute zero. **(5 Lectures)**

Thermodynamical Potentials: Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Maxwell's relations and applications - Joule-Thompson Effect, Clausius-Clapeyron Equation, Expression for (CP – CV), CP/CV, TdS equations. **(10 Lectures)**

MODULE 3

Kinetic Theory of Gases: Derivation of Maxwell's law of distribution of velocities and its experimental verification, Mean free path (Zeroth Order), Transport Phenomena: Viscosity, Conduction and Diffusion (for vertical case), Law of equipartition of energy (no derivation) and its applications to specific heat of gases; mono-atomic and diatomic gases. **(10 Lectures)**

Theory of Radiation: Blackbody radiation, Spectral distribution, Concept of Energy Density, Derivation of Planck's law, Deduction of Wien's distribution law, Rayleigh-Jeans Law, Stefan Boltzmann Law and Wien's displacement law from Planck's law. **(5 Lectures)**

MODULE 4

Statistical Mechanics: Phase space, Macrostate and Microstate, Entropy and Thermodynamic probability, Maxwell-Boltzmann law - distribution of velocity - Quantum statistics - Fermi-Dirac distribution law - electron gas - Bose-Einstein distribution law - photon gas - comparison of three statistics. **(15 Lectures)**

TEXT BOOKS

1. Thermal Physics, S. Garg, R. Bansal and C. Ghosh, 1993, Tata McGraw-Hill.
2. A Treatise on Heat, Meghnad Saha, and B.N. Srivastava, 1969, Indian Press.
3. Thermodynamics, Kinetic theory & Statistical thermodynamics, F.W.Sears and G.L. Salinger. 1988, Narosa

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REFERENCE BOOKS

1. Thermodynamics, Enrico Fermi, 1956, Courier Dover Publications.
2. Heat and Thermodynamics, M.W.Zemasky and R. Dittman, 1981, McGraw Hill
3. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
4. Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. chand Publications.

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PHY-GE-004 (Practical) : GENERIC PHYSICS LABORATORY IV

Credit: 2 (L- 0:T- 0: P-2)

Practical: 60 Hours

COURSE OBJECTIVES

Demonstration and practical laboratory experiments on to understand some basic concept and phenomenon of thermal physics.

COURSE LEARNING OUTCOME

- construction and use of specific measurement instruments and experimental apparatuses used in the thermal physics lab, including necessary precautions
- Analysis of experimental data, error estimation and writing scientific reports.

SKILLS TO BE LEARNED

- Hand on experience on Thermal physics related phenomena.
- Arrangement of of experimental set-up related to thermal physics.
- Data analysis, error calculation and laboratory report preparation

DETAILED CONTENTS OF THE COURSE

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
2. Measurement of Planck's constant using black body radiation.
3. To determine Stefan's Constant.
4. To determine the coefficient of thermal conductivity of Cu by Searle's Apparatus.
5. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.
6. To determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method.
7. To determine the temperature co-efficient of resistance by Platinum resistance thermometer.
8. To study the variation of thermo emf across two junctions of a thermocouple with temperature.
9. To record and analyze the cooling temperature of an hot object as a function of time using a thermocouple and suitable data acquisition system
10. To calibrate Resistance Temperature Device (RTD) using Null Method/Off-Balance Bridge.

TEXT BOOKS

1. A Laboratory Manual of Physics for Undergraduate Classes, D.P. Khandelwal, 1985, Vani Publication.

REFERENCE BOOKS

1. Advanced Practical Physics for students, B.L.Flint&H.T.Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practical, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
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ASSESSMENT: MARKING SCHEME

Total Marks: 50

- **Internal assessment:** 10 marks
- **End term examination:** 40 (laboratory examination will be conducted at the semester end)
  - Laboratory Notebook: 10 Marks
  - Experimental work and data analysis: 10 Marks
  - Presentation and Viva voce: 20 Marks

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Jt. Registrar (Acad. & Conf.)
Rajiv Gandhi University
Rono Hills, Doimukh (A.P.)

ABILITY ENHANCEMENT CUMPULSORY COURSES (AEC)

ENG-AE-111 Communicative English

Credit: L3:T1:P0 Lecture Hour: 40

Course Objective

The course aims to train learners to be more effective at communicating successfully in interviews, public speaking, letter writing, report writing, presentations, and inter-personal debates and conversations. The learner also imbibes the fundamentals of communication and the art of persuasive speaking and writing which depends crucially on clarity of thought and contextual understanding expressed through appropriate vocabulary.

Course Outcome

After completion of the course, learners will be able to master the art of persuasive speech and writing, the art of listening, reading, and analysing; spend the bulk of their time in class in practical exercises of reading and writing; develop critical thinking skills; and they will be introduced to established principles of academic reading and writing. Other specific outcomes:

- Identify deviant use of English both in written and spoken forms
- Recognize the errors of usage and correct them and write simple sentences without committing errors of spelling and grammar
- Developing own competence in using the language
- Understand and appreciate English spoken by others
- Use language for speaking with confidence in an intelligible and acceptable manner
- Understand the importance of reading for life and develop an interest for reading
- Read independently unfamiliar texts with comprehension
- Understand the importance of writing in academic life and career.

Module 01: **Poetry:** William Shakespeare – All the World is a stage; William Wordsworth – I wondered lonely as a Cloud; Ralph Waldo Emerson – The Mountain and the Squirrel; Emily Dickinson – Success is Counted Sweetest; Robert Frost - Stopping by Woods on a Snowy Evening; Rabindranath Tagore – Where the Mind is without Fear; A. K. Meherotra – Songs of the Ganga.

Module 02: **Short Stories:** R.K. Narayan – Lawly Road; Mulk Raj Anand – Barbar's Trade Union; Somerset Mangham – The Luncheon; Guy De. Maupassant – The Necklace; Anton Chekhov – The Lament; O' Henry – The Last Leaf; Manoj Das – The Submerged Valley.

Module 03: **One-Act Plays and Short Fiction:** (a) Norman Mckinnell - The Bishop's Candle Sticks; Anton Chekov – A Marriage Proposal; Eugene Lonesco – The Lesson; August Strandberg – Miss Jullie; Fritz Karinthy– Refund; (b) Harper Lee – To kill a Mocking Bird, (Or) R. K. Narayan – Vendor of Sweets.

Module 04: **Fundamentals of Grammar**: Parts of speech, Articles and Intensifiers, use of tense forms, Use of Infinitives, Conditionals, Adjectives and Adverbs, Prepositions, Making Affirmative, Negative and Interrogative, Making Question Tag.

Module 05: **Composition Practice:** (a) Comprehension, Précis Writing, Paragraph Writing (150 words), Letter writing – Personal, Official, Demi-official, Business, Public speaking, Soft Skills, Interviews, Preparing Curriculum Vitae, Report (Meetings and Academic) writing; (b) Communication Practice – Introducing yourself, Introducing people to others, Meeting People, Exchanging Greetings, Taking Leave, Answering the Telephone, Asking Someone for Some Purpose, Taking and Leaving Messages, Call for help in emergency.

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Module	Weightage of Marks	Theory	Practical
Module 01	20%	✔	
Module 02	20%	✔	
Module 03	20%	✔	
Module 04	20%	✔	✔
Module 05	20%	✔	✔

Practical Exercises

The students are required to:

1. know dictionary and its types, mapping a dictionary to locate words, and multiple uses of dictionary/ies
2. know the uses of Thesaurus/Lexicon/Activator/Encyclopaedia
3. know Note making/taking
4. know information transfer exercises
5. know the usage library resources properly
6. know citing references or developing a bibliography
7. Edit a piece of self and peer writing, writing and revising the drafts and preparing the final draft
8. Understand and appreciate the principle of politeness in relation to the speaker/ listener, debating, ex-tempore speeches, and other discourses.

Suggested Readings

Crystal, David (1985) Rediscover Grammar with David Crystal. Longman.

Hewings, M. (1999) Advanced English Grammar. Cambridge University Press.

Bakshi, R. N. A course in English Grammar, Orient Longman

Krishnaswamy, N. Modern English – A Book of Grammar, Usage and Composition. MacMillan India Ltd.

Bailey, Stephen (2003). Academic Writing. London and New York, Routledge.

Grellet, F (1981). Developing Reading Skills: A Practical Guide to Reading Skills. New York, CUP

Hedge, T. (2005). Writing. London, OUP

Kumar, S and Pushp Lata (2015). Communication Skills. New Delhi, OUP

Lazar, G. (2010). Literature and Language Teaching. Cambridge, CUP

Nuttall, C (1996). Teaching Reading Skills in a Foreign Language. London, Macmillan

Raman, Meenakshi and Sangeeta Sharma (2011). Technical Communication: Principles and Practice. New Delhi, OUP

Note: Students are advised to use latest edition of text books. For reading the texts, available sources of texts and help of the Web source may be taken.

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HIN-AE-111 हिंदी शिक्षण (Hindi Sikshan)

क्रेडिट (Credit): L3:T1:P0 व्याख्यान घंटे (Lecture Hours): 40

(यह पत्र प्रथम सत्र में हिन्दी कौशलाधारित पाठ्यक्रम चुनने वाले सभी विद्यार्थियों के लिये हैं। यह पत्र चार इकाइयों में विभक्त है। प्रत्येक इकाई के लिये व्याख्यानों की संख्या निर्धारित हैं)

उद्देश्य: *सामाजिक, व्यवसायिक, कार्यालयी तथा शैक्षणिक परिप्रेक्ष्य में विद्यार्थियों के भाषा-कौशल में निखार लाना। विद्यार्थियों में प्रतिस्पर्धात्मक परीक्षाओं एवं साक्षात्कार हेतु आत्मविश्वास उत्पन्न करना। विद्यार्थियों में रचनात्मक कौशल विकसित करना। भाषा-ज्ञान के माध्यम से विद्यार्थियों को रोजगारोन्मुख शिक्षा प्रदान करना।*

इकाई 1: राष्ट्रीय एवं अन्तरराष्ट्रीय परिप्रेक्ष्य में हिन्दी का महत्त्व; मानक हिन्दी और बोलचाल की हिन्दी में अन्तर; स्वागत भाषण, भाषण, विषय प्रवर्तन तथा धन्यवाद ज्ञापन। व्याख्यान – 10

इकाई 2: आलेख रचना: सम्पादक के नाम पत्र, सम्पादकीय लेखन, स्तम्भ लेखन, पत्र पत्रिकाओं के लिये आलेख रचना-; आकाशवाणी एवं दूरदर्शन हेतु वार्ता, साक्षात्कार एवं परिचर्चा तैयार करने की विधियाँ। व्याख्यान – 10

इकाई 3: व्यावहारिक लेखन: कार्यालयी पत्राचार; प्रेस विज्ञप्ति; सूचना ; ज्ञापन; कार्यसूची; कार्यवृत्त; प्रतिवेदन; सम्पादन; संक्षेपण; आत्मविवरण तथा ईमेल लेखन-, फेसबुक, ब्लॉग और ट्वीटर लेखन। व्याख्यान – 10

इकाई 4: सृजनात्मक लेखन: कविता, कहानी, नाटक तथा एकांकी, निबंध, यात्रावृत का स्वरूप विवेचन। व्याख्यान – 10

उपलब्धियां -हिंदी शिक्षण से सम्बन्धित इस पत्र में विद्यार्थी हिन्दी भाषा के व्यावहारिक स्वरूप तथा प्रयोजनमूलक हिन्दी के क्षेत्र लेखन से जुड़ी बहुविध जानकारियों से परिचित हुए। हिन्दी भाषा की बढ़ती लोकप्रियता और बढ़ते अन्तरराष्ट्रीय महत्त्व के सन्दर्भ में हिन्दी भाषा आधारित कौशल विकास से विद्यार्थियों को अवगत कराया गया। विशेषकर आलेख रचना के अतिरिक्त व्यावहारिक एवं सर्जनात्मक लेखन से जुड़ी बारीकियों को जान सके।

कार्य सम्पादन पद्धति: व्याख्यान, विचारविमर्श-, समूहचर्चा-, सामग्री-समीक्षा और प्रस्तुतीकरण आदि।

Module	Weightage of Marks	Theory	Practical / Numerical
Module 01	25%	✔	✔
Module 02	25%	✔	✔
Module 03	25%	✔	✔
Module 04	25%	✔	

सहायक ग्रन्थ

1. अच्छी हिन्दी : रामचन्द्र वर्मा
2. व्यवहारिक हिन्दी व्याकरण और रचना : हरदेव बाहरी
3. हिन्दी भाषा : डॉ भोलानाथ तिवारी
4. रेडियों लेखन : मधुकर गंगाधर
5. टेलीविजनः सिद्धान्त और टैकनिक : मथुरादत्त शर्मा
6. प्रयोजनमूलक हिन्दी : डॉ दंगल झाल्टे
7. सरकारी कार्यालयों में हिन्दी का प्रयोग : गोपीनाथ श्रीवास्तव, राजकमल, दिल्ली
8. टेलीविजन लेखन : असगर वजाहत / प्रेमरंजन; राजकमल, दिल्ली
9. रेडियो नाटक की कला : डॉ सिद्धनाथ कुमार, राजकमल, दिल्ली
10. रेडियो वार्ता शिल्प : सिद्धनाथ कुमार, राजकमल, दिल्ली

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EVS-AE-121: ENVIRONMENTAL STUDIES

Credits: L4:T0:P0 = 4 Credits

Course Objective

The objective of this paper is to provide basic concept of on Environment, Ecology, Natural Resources, Importance of biodiversity and need for their conservation along with various environmental issues and Govt. policies, and Environmental movements.

Learning outcomes

- Learners will be able to understand environment science and its importance.
- Learners will understand the various types of pollution and hazards caused by them.
- Learners will understand ways to monitor environment and the various green technologies.
- Learners will know the various Acts enacted for the protection of the environment.

Key Words: Environment, Ecosystem, Natural Resources, Biodiversity, Environmental Issues and Policies

Unit I: Basic Concept of Environment **12 Lectures**

Environment: Definition, scope and importance; Multidisciplinary nature of environmental studies. Concept of sustainability and sustainable development.
Ecosystem – Concept, Structure and function; Energy flow in an ecosystem: food chains, food webs, ecological pyramid. Ecological succession. Ecosystem services.

Unit II: Natural Resources **12 Lectures**

Land as a resource, Land use patterns, land degradation, soil erosion and desertification.
Forest Resources, Use and over-exploitation; Deforestation - causes and impacts on environment.
Water Resources, Use and over-exploitation of surface and ground water; floods, droughts, Case studies on conflicts over water (international & inter-state).
Energy Resources, Renewable and non-renewable energy sources, growing energy needs, use of alternate energy sources.
Traditional ecological knowledge.

Unit III: Biodiversity and Conservation **12 Lectures**

Biodiversity: Definition, levels (genetic, species and ecosystem diversity) and values; Biogeographic zones of India; Biodiversity hot spots. Threats to biodiversity: Habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions.
Conservation of biodiversity: *In-situ* and *Ex-situ* conservation of biodiversity.
Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value.

Unit IV: Environmental Issues and Policies **24 Lectures**

Environmental pollution: types, causes, effects and controls of Air, water, soil, noise, solid waste and nuclear pollution.
Global environmental issues: Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture.
Salient features of Environment Laws: Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act. International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD). Paris agreement, Nagoya Protocol.
Human Communities and the Environment: Human population growth: Impacts on environment, human health and welfare.
Disaster management: Floods, Earthquake, Cyclones and Landslides.
Environmental movements: Chipko, Silent valley, Bishnois of Rajasthan.

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Suggested readings

Bharucha, E. 2020. Textbook for Environmental Science for undergraduate students. University Grants Commission, New Delhi.

Gupta Abhik and Gupta Susmita. 2021. Environmental Studies: Principles and Practices. 344 pages, SAGE Texts.

Ahluwalia, V.K.. Environmental Studies. 2nd Ed. TERI Press.

Kaushik Anubha and Kaushik, C.P. 2018. Perspectives in Environmental Studies. 6th Ed. New Age International Pvt. Ltd.

Krishnamurthy, K. V. 2020.An advanced textbook on Biodiversity: Principles and Practice. CBS Publisher and Distributors

Ambasht, R. S. and Ambasht, P.K. 2017. Environment and Pollution an Ecological Approach 5th Ed. CBS Publisher and Distributors.

Ambasht, R. S. and Ambasht, N.K. 2017. A textbook of Plant Ecology. 15th Ed. CBS Publishers and Distributors, New Delhi.

Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. Ecology, Environmental Science and Conservation. S. Chand Publishing, New Delhi.

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