NOIDA INTERNATIONAL UNIVERSITY

DEPARTMENT OF PHYSICS

SYLLABUS OF COURSES TO BE OFFERED

Core Courses, Elective Courses & Ability Enhancement Courses

UNDERGRADUATE PROGRAMME

Choice Based Credit System (CBCS)

(Academic Year 2019-20)

Preamble

The University Grants Commission (UGC) has initiated several measures to bring equity, efficiency and excellence in the Higher Education System of country. The important measures taken to enhance academic standards and quality in higher education include innovation and improvements in curriculum, teaching-learning process, examination and evaluation systems, besides governance and other matters.

The UGC has formulated various regulations and guidelines from time to time to improve the higher education system and maintain minimum standards and quality across the Higher Educational Institutions (HEIs) in India. The academic reforms recommended by the UGC in the recent past have led to overall improvement in the higher education system. However, due to lot of diversity in the system of higher education, there are multiple approaches followed by universities towards examination, evaluation and grading system. While the HEIs must have the flexibility and freedom in designing the examination and evaluation methods that best fits the curriculum, syllabi and teaching–learning methods, there is a need to devise a sensible system for awarding the grades based on the performance of students. Presently the performance of the students is reported using the conventional system of marks secured in the examinations or grades or both. The conversion from marks to letter grades and the letter grades used vary widely across the HEIs in the country. This creates difficulty for the academia and the employers to understand and infer the performance of the students graduating from different universities and colleges based on grades.

The grading system is considered to be better than the conventional marks system and hence it has been followed in the top institutions in India and abroad. So, it is desirable to introduce uniform grading system. This will facilitate student mobility across institutions within and across countries and also enable potential employers to assess the performance of students. To bring in the desired uniformity, in grading system and method for computing the cumulative grade point average (CGPA) based on the performance of students in the examinations, the UGC has formulated these guidelines.

CHOICE BASED CREDIT SYSTEM (CBCS)

The CBCS provides an opportunity for the students to choose courses from the prescribed courses comprising core, elective/minor or skill-based courses. The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. Therefore, it is necessary to introduce uniform grading system in the entire higher education in India. This will benefit the students to move across institutions within India to begin with and across countries. The uniform grading system will also enable potential employers in assessing the performance of the candidates. In order to bring uniformity in evaluation system and computation of the Cumulative Grade Point

Average (CGPA) based on student's performance in examinations, the UGC has formulated the guidelines to be followed.

Outline of Choice Based Credit System:

1. **Core Course:** A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.
2. **Elective Course:** Generally, a course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/ subject of study or which provides an extended scope or which enables an exposure to some other discipline/subject/domain or nurtures the candidate's proficiency/skill is called an Elective Course.
   2.1 Discipline Specific Elective (DSE) Course: Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective. The University/Institute may also offer discipline related Elective courses of interdisciplinary nature (to be offered by main discipline/subject of study).
   2.2 Dissertation/Project: An elective course designed to acquire special/advanced knowledge, such as supplement study/support study to a project work, and a candidate studies such a course on his own with an advisory support by a teacher/faculty member is called dissertation/project.
   2.3 Generic Elective (GE) Course: An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a Generic Elective.
   P.S.: A core course offered in a discipline/subject may be treated as an elective by other discipline/subject and vice versa and such electives may also be referred to as Generic Elective.
3. **Ability Enhancement Courses (AEC)/Competency Improvement Courses/Skill Development Courses/Foundation Course:** The Ability Enhancement (AE) Courses may be of two kinds: AE Compulsory Course (AECC) and AE Elective Course (AEEC). "AECC" courses are the courses based upon the content that leads to Knowledge enhancement. They ((i) Environmental Science, (ii) English/MIL Communication) are mandatory for all disciplines. AEEC courses are value-based and/or skill-based and are aimed at providing hands-on-training, competencies, skills, etc.
   3.1 AE Compulsory Course (AECC): Environmental Science, English Communication/MIL Communication.
   3.2 AE Elective Course (AEEC): These courses may be chosen from a pool of courses designed to provide value-based and/or skill-based instruction.

Project work/Dissertation is considered as a special course involving application of knowledge in solving / analyzing /exploring a real-life situation / difficult problem. A Project/Dissertation work would be of 6 credits. A Project/Dissertation work may be given in lieu of a discipline specific elective paper.

PROGRAM LEARNING OUTCOMES

The student graduating with the Degree B. Sc Physics (Hons) should be able to

- Acquire (i) a fundamental/systematic or coherent understanding of the academic field of Physics, its different learning areas and applications in basic Physics like Astrophysics, Material science, Nuclear and Particle Physics, Condensed matter Physics, Atomic and Molecular Physics, Mathematical Physics, Analytical dynamics, Space science, and its linkages with related disciplinary areas/subjects like Chemistry, Mathematics, Life sciences, Environmental sciences, Atmospheric Physics, Computer science, Information Technology; (ii) procedural knowledge that creates different types of professionals related to the disciplinary/subject area of Physics, including professionals engaged in research and development, teaching and government/public service; (iii) skills in areas related to one's specialization area 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 modeling simulation and computing, and the role of approximation and mathematical approaches to describing the physical world.

- 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 (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 behavior such as (i) being objective, unbiased and truthful in all aspects of work and avoiding unethical, irrational behavior such as fabricating, falsifying or misrepresenting data or committing plagiarism; (ii) the ability to identify the potential ethical issues in work-related situations; (iii) appreciation of intellectual property, environmental and sustainability issues; and (iv) promoting safe learning and working environment.

Course Structure

Details of courses under B.Sc. Physics (Hons)

Course	*Credits Theory+ Practical	Theory + Tutorial
I. Core Course		
(14 Papers)	14X4= 56	14X5=70
Core Course Practical / Tutorial*		
(14 Papers)	14X2=28	14X1=14
II. Elective Course		
(8 Papers)		
A.1. Discipline Specific Elective	4X4=16	4X5=20
(4 Papers)		
A.2. Discipline Specific Elective Practical/Tutorial*	4 X 2=8	4X1=4
(4 Papers)		
B.1. Generic Elective/ Interdisciplinary	4X4=16	4X5=20
(4 Papers)		
B.2. Generic Elective Practical/ Tutorial*	4 X 2=8	4X1=4
(4 Papers)		

- **Optional Dissertation or project work in place of one Discipline Specific Elective paper (6 credits) in 6th Semester**

Course	Theory+ Practical	Theory + Tutorial
III. Ability Enhancement Courses		
1. **Ability Enhancement Compulsory**		
(2 Papers of 2 credit each)	2 X 2=4	2X 2=4
Environmental Science		
English/MIL Communication		
2. **Ability Enhancement Elective** (Skill Based)		
(Minimum 2)	2 X 2=4	2 X 2=4
(2 Papers of 2 credit each)		
Total credit	**140**	**140**

*** Wherever there is a practical there will be no tutorial and vice-versa**

SCHEME FOR CHOICE BASED CREDIT SYSTEM IN BSc Physics (Hons)

Semester	Core Course (14)	Ability Enhancement Compulsory Course (AECC) (2)	Skill Enhancement Course (SEC) (2)	Elective: Discipline Specific (DSE) (4)	Elective: Generic (GE) (4)
I	Mathematical Physics I	AECC-1 Environmental Science			GE-1
	Mechanics				
II	Electricity& Magnetism	AECC-2 Communicative Alternative English			GE-2
	Waves and Optics				
III	Mathematical Physics II		AEEC-1/SEC-1		GE-3
	Thermal Physics				
	Digital Systems and Applications				
IV	Mathematical Physics III		AEEC-2/SEC-2		GE-4
	Elements of Modern Physics				
	Analog Systems and Applications				
V	Quantum Mechanics and Applications			DSE-1	
	Solid State Physics			DSE-2	
VI	Electromagnetic Theory			DSE-3	
	Statistical Mechanics			DSE-4	

SEM	COURSE OPTED	COURSE NAME	Credits
I	Ability Enhancement Compulsory Course- I	Communicative English	2
	Core Course-I	Mathematical Physics-I	4
	Core Course-I Practical/Tutorial	Mathematical Physics-I Lab	2
	Core course-II	Mechanics	4
	Core Course-II Practical/Tutorial	Mechanics Lab	2
	Generic Elective -1	GE-1	4/5
	Generic Elective -1 Practical/Tutorial		2/1
II	Ability Enhancement Compulsory Course- II	Environmental Science	2
	Core course-III	Electricity and Magnetism	4
	Core Course-III Practical/Tutorial	Electricity and Magnetism Lab	2
	Core course-IV	Waves and Optics	4
	Core Course-IV Practical/Tutorial	Waves and Optics Lab	2
	Generic Elective -2	GE-2	4/5
	Generic Elective -2 Practical/Tutorial		2/1
III	Core course-V	Mathematical Physics-II	4
	Core Course-V Practical/Tutorial	Mathematical Physics-II Lab	2
	Core course-VI	Thermal Physics	4
	Core Course-VI Practical/Tutorial	Thermal Physics Lab	2
	Core course-VII	Digital Systems and Applications	4
	Core Course-VII Practical/Tutorial	Digital Systems and Applications Lab	2
	Skill Enhancement Course -1/Ability Enhancement Elective Course-1	SEC-1/AEEC-1	2
	Generic Elective -3	GE-3	4/5
	Generic Elective -3 Practical/Tutorial		2/1
IV	Core course-VIII	Mathematical Physics III	4
	Course-VIII Practical/Tutorial	Mathematical Physics-III Lab	2
	Core course-IX	Elements of Modern Physics	4
	Course-IX Practical/Tutorial	Elements of Modern Physics Lab	2
	Core course-X	Analog Systems and Applications	4
	Course- X Practical/Tutorial	Analog Systems and Applications Lab	2
	Skill Enhancement Course -2/Ability Enhancement Elective Course-2	SEC -2/AEEC-2	2
	Generic Elective -4	GE-4	4/5
	Generic Elective -4 Practical/Tutorial		2/1
V	Core course-XI	Quantum Mechanics and Applications	4
	Core Course-XI Practical/Tutorial	Quantum Mechanics and	2

		Applications Lab	
	Core course-XII	**Solid State Physics**	**4**
	Core Course-XII Practical/Tutorial	**Solid State Physics Lab**	**2**
	Discipline Specific Elective -1	**DSE-1**	**4/5**
	Discipline Specific Elective -1 Practical/Tutorial	**DSE-1 Lab**	**2/1**
	Discipline Specific Elective -2	**DSE-2**	**4/5**
	Discipline Specific Elective- 2 Practical/Tutorial	**DSE-2 Lab**	**2/1**
VI	**Core course-XIII**	**Electro-magnetic Theory**	**4**
	Core Course-XIII Practical/Tutorial	**Electro-magnetic Theory Lab**	**2**
	Core course-XIV	**Statistical Mechanics**	**4**
	Core Course-XIV Practical/Tutorial	**Statistical Mechanics Lab**	**2**
	Discipline Specific Elective -3	**DSE-3**	**4/5**
	Discipline Specific Elective -3 Practical/Tutorial	**DSE-3 Lab**	**2/1**
	Discipline Specific Elective-4	**DSE-4**	**4/5**
	Discipline Specific Elective -4 Practical/Tutorial	**DSE-4 Lab**	**2/1**
Total Credits			**140**

Core Papers (C): (Credit: 06 each) (1 period/week for tutorials or 4 periods/week for practical)

1. Mathematical Physics-I
2. Mechanics
3. Electricity and Magnetism
4. Waves and Optics
5. Mathematical Physics–II
6. Thermal Physics
7. Digital Systems and Applications
8. Mathematical Physics III
9. Elements of Modern Physics
10. Analog Systems and Applications
11. Quantum Mechanics and Applications
12. Solid State Physics
13. Electromagnetic Theory
14. Statistical Mechanics

Discipline Specific Elective Papers: (Credit: 06 each) (4 papers to be selected) - DSE 1-4

1. Classical Dynamics + Tut
2. Nuclear and Particle Physics + Tut
3. Astronomy and Astrophysics + Tut
4. Physics of the Earth + Tut
5. Physics of Devices and Communication + Lab
6. Nano Materials and Applications + Lab
7. Experimental Techniques + Lab

Other Discipline - GE 1 to GE 4

1. Mathematics + Tut
2. Chemistry + Lab
3. Computer Science + Lab
4. Electronics + Lab
5. Statistics + Tut

(Relevant subject to be decided upon by the BOS in Physics from time to time)

Skill Enhancement Courses (02 to 04 papers) (Credit: 02 each) - SEC1 to SEC4

1. Applied Optics
2. Physics Workshop Skills
3. Basic Instrumentation Skills
4. Renewable Energy and Energy harvesting
5. Electrical circuits and Network Skills
6. Technical Drawing
7. Radiation Safety
8. Weather Forecasting

Generic Elective Papers (GE) for other Departments/Disciplines: (Credit: 06 each)

1. Mechanics + Lab
2. Electricity and Magnetism + Lab
3. Thermal Physics + Lab
4. Waves and Optics + Lab

NOIDA INTERNATIONAL UNIVERSITY

SCHOOL OF SCIENCES

Study & Evaluation Scheme for B.Sc. Physics (Hons)

Effective from the Session: 2019-20

SEMESTER-I

S. No	Course Name	Course Code	Course Type	Period			Evaluation Scheme				Subject Total	Credit
										External Exam		
				L	T	P	CA	TA	Total			
1	Mathematical Physics I	STUGP/C01	Core	4	0	0	20	20	40	60	100	4
2	Mechanics	STUGP/C02	Core	4	0	0	20	20	40	60	100	4
3	Fundamentals of Computer Applications	STUGP/GE01	GE	4	0	0	20	20	40	60	100	4
4	Environmental Sciences	STUGP/AECC01	AECC	2	0	0	20	20	40	60	100	2
				Practical								
1	Mathematical Physics I Lab	SPUGP/C01	Core	0	0	2	-	-	25	25	50	2
2	Mechanics Lab	SPUGP/C02	Core	0	0	2	-	-	25	25	50	2
3	Fundamentals of Computer Applications Lab	SPUGP/GE01	GE	0	0	2	-	-	25	25	50	2
Total											**550**	**20**

SEMESTER-II

S. No	Course Name	Course Code	Course Type	Period			Evaluation Scheme				Subject Total	Credit
										External Exam		
				L	T	P	CA	TA	Total			
1	Electricity& Magnetism	STUGP/C03	Core	4	0	0	20	20	40	60	100	4
2	Waves and Optics	STUGP/C04	Core	4	0	0	20	20	40	60	100	4
3	Operating System	STUGCS/C03	GE	4	0	0	20	20	40	60	100	4
4	Technical Communication	STUGP/AECC02	AECC	2	0	0	20	20	40	60	100	2
				Practical								
1	Electricity& Magnetism Lab	SPUGP/C03	Core	0	0	2	-	-	25	25	50	2
2	Waves and Optics Lab	SPUGP/C04	Core	0	0	2	-	-	25	25	50	2
3	Operating System Lab	SPUGCS/C03	GE	0	0	2	-	-	25	25	50	2
Total											**550**	**20**

SEMESTER-III

S. No	Course Name	Course Code	Course Type	Period			Evaluation Scheme				Subject Total	Credit
				L	T	P	CA	TA	Total	External Exam		
1	Mathematical Physics II	STUGP/C05	Core	4	0	0	20	20	40	60	100	4
2	Thermal Physics	STUGP/C06	Core	4	0	0	20	20	40	60	100	4
3	Digital Systems and Applications	STUGP/C07	Core	4	0	0	20	20	40	60	100	4
4	Environmental Chemistry	STUGC/C07	GE	4	0	0	20	20	40	60	100	4
5	✓Applied Optics ✓Physics Workshop Skills ✓Basic Instrumentation Skills ✓Renewable Energy and Energy harvesting (Any One to be Opted)	STUGP/AEEC01 STUGP/AEEC02 STUGP/AEEC03 STUGP/AEEC04	AEEC	2	0	0	20	20	40	60	100	2
Practical												
1	Mathematical Physics II Lab	SPUGP/C05	Core	0	0	2	-	-	25	25	50	2
2	Thermal Physics Lab	SPUGP/C06	Core	0	0	2	-	--	25	25	50	2
3	Digital Systems and Applications Lab	SPUGP/C07	Core	0	0	2	-	-	25	25	50	2
4	Environmental Chemistry Lab	SPUGC/C07	GE	0	0	2	--	-	25	25	50	2
Total											**700**	**26**

SEMESTER-IV

S. No	Course Name	Course Code	Course Type	Period			Evaluation Scheme				Subject Total	Credit
				L	T	P	CA	TA	Total	External Exam		
1	Mathematical Physics III	STUGP/C08	Core	4	0	0	20	20	40	60	100	4
2	Elements of Modern Physics	STUGP/C09	Core	4	0	0	20	20	40	60	100	4
3	Analog Systems and Applications	STUGP/C10	Core	4	0	0	20	20	40	60	100	4
4	Green Chemistry	STUGC/C10	GE	4	0	0	20	20	40	60	100	4
5	✓Electrical circuits and Network Skills ✓Technical Drawing ✓Radiation Safety ✓Weather Forecasting (Any One to be Opted)	STUGP/AEEC05 STUGP/AEEC06 STUGP/AEEC07 STUGP/AEEC08	AEEC	2	0	0	20	20	40	60	100	2
Practical												
1	Mathematical Physics III Lab	SPUGP/C08	Core	0	0	2	-	-	25	25	50	2
2	Elements of Modern Physics Lab	SPUGP/C09	Core	0	0	2	-	-	25	25	50	2
3	Analog Systems and Applications Lab	SPUGP/C10	Core	0	0	2	-	-	25	25	50	2
4	Green Chemistry Lab	SPUGC/C10	GE	0	0	2	-	-	25	25	50	2
Total											**700**	**26**

SEMESTER-V

S. No	Course Name	Course Code	Course Type	Period			Evaluation Scheme				Subject Total	Credit
										External Exam		
				L	T	P	CA	TA	Total			
1	Quantum Mechanics and Applications	STUGP/C11	Core	4	0	0	20	20	40	60	100	4
2	Solid State Physics	STUGP/C12	Core	4	0	0	20	20	40	60	100	4
3	✓ Classical Dynamics ✓ Nuclear and Particle Physics ✓ Astronomy and Astrophysics ✓ Physics of the Earth (Any two to be Opted)	STUGP/DSE01 STUGP/DSE02 STUGP/DSE03 STUGP/DSE04	DSE	5	1	0	20	20	40	60	100*2	6*2
Practical												
1	Quantum Mechanics and Applications Lab	SPUGP/C11	Core	0	0	2	-	-	25	25	50	2
2	Solid State Physics Lab	SPUGP/C12	Core	0	0	2	-	-	25	25	50	2
Total											**600**	**24**

SEMESTER-VI

S. No	Course Name	Course Code	Course Type	Period			Evaluation Scheme				Subject Total	Credit
				L	T	P	CA	TA	Total	External Exam		
1	Electromagnetic Theory	STUGP/C13	Core	4	0	0	20	20	40	60	100	4
2	Statistical Mechanics	STUGP/C14	Core	4	0	0	20	20	40	60	100	4
3	✓ Physics of Devices and Communication ✓ Nano Materials and Applications ✓ Experimental Techniques (Any two to be Opted)	STUGP/DSE05 STUGP/DSE06 STUGP/DSE07	DSE	4	0	0	20	20	40	60	100*2	4*2
	Practical											
1	Electromagnetic Theory Lab	SPUGP/C13	Core	0	0	2	-	-	25	25	50	2
2	Statistical Mechanics Lab	SPUGP/C14	Core	0	0	2	-	-	25	25	50	2
3	✓ Physics of Devices and Communication Lab ✓ Nano Materials and Applications Lab ✓ Experimental Techniques Lab (Any two to be Opted)	SPUGP/DSE05 SPUGP/DSE06 SPUGP/DSE07	DSE	0	0	2	-	-	25	25	50*2	2*2
Total											**600**	**24**

Semester I

Course Code: S T U G P / C 0 1
Course Title: MATHEMATICAL PHYSICS – I
Nature of the Course: CORE
Total Credits assigned: 06
Distribution of credit: Theory – 04, Practicals-02

Course Objectives: At the completion of this course, a student will be able to

1. Write a problem in Physics in the language of Mathematics.
2. Identify a range of diverse mathematical techniques to formulate and solve a problem in basic Physics.
3. Analyze some of the basic mathematical concepts and methods.
4. Apply the knowledge and understanding of these mathematical methods to solve problems in a number of elementary branches of Physics like mechanics, electromagnetic theory, statistical Physics, thermal Physics etc.
5. Learn computer programming and numerical analysis and know its role in solving problems in Physics.
6. Construct a problem in Physics computationally.

MATHEMATICAL PHYSICS-I (THEORY)
60 Lectures, 60 Marks

Calculus:
Recapitulation: Limits, continuity, average and instantaneous quantities, differentiation. Plotting functions. Intuitive ideas of continuous, differentiable, etc. functions and plotting of curves. Approximation: Taylor and binomial series (statements only).
(2 Lectures, 2 Marks)

First Order and Second Order Differential equations: 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, 13 Marks)

Calculus of functions of more than one variable: Partial derivatives, exact and inexact differentials. Integrating factor, with simple illustration. Constrained Maximization using Lagrange Multipliers.
(6 Lectures, 6 Marks)

Vector Calculus:
Recapitulation of vectors: Properties of vectors under rotations. Scalar product and its invariance under rotations. Vector product, Scalar triple product and their interpretation in terms of area and volume respectively. Scalar and Vector fields.
(5 Lectures, 5 Marks)

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, 8 Marks)

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).
(14 Lectures, 14 Marks)

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

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.
(4 Lectures, 4 Marks)

Dirac Delta function and its properties:
Definition of Dirac delta function. Representation as limit of a Gaussian function and rectangular function. Properties of Dirac delta function.
(2 Lectures, 2 Marks)

Recommended readings:

- Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013, 7th Edn., Elsevier.
- An introduction to ordinary differential equations, E.A. Coddington, 2009, PHI learning
- Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Book
- Advanced Engineering Mathematics, D.G. Zill and W.S. Wright, 5 Ed., 2012, Jones and Bartlett Learning
- Mathematical Physics, Goswami, 1st edition, Cengage Learning
- Engineering Mathematics, S. Pal and S.C. Bhunia, 2015, Oxford University Press
- Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
- Essential Mathematical Methods, K.F. Riley & M.P. Hobson, 2011, Cambridge Univ. Press

Mode of Assessment/ Assessment Tools (%)

Internal: 40
Assignment /Presentation/ attendance/ Class room interaction/quiz etc: 20
Written Test for theory and/or Viva Voce for Laboratory: 20
Final (End Semester): 60
Written Test for theory and/or Laboratory experiments: 60

MATHEMATICAL PHYSICS-I (LAB)

60 Lectures

The course will consist of lectures (both theory and practical) in the Lab. Evaluation is to be done not on the programming but on the basis of formulating the problem. Students can use any one operating system: Linux or Microsoft Windows .

Topics	Description with Applications
Introduction and Overview	Computer architecture and organization, memory and Input/output devices
Basics of scientific computing	Binary and decimal arithmetic, Floating point numbers, algorithms, Sequence, Selection and Repetition, single and double precision arithmetic, underflow &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 & 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. 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
Programs	Sum & average of a list of numbers, largest of a given list of numbers and its location in the list, sorting of numbers in ascending descending order, Binary search
Random number generation	Area of circle, area of square, volume of sphere, value of Pi (π)
Solution of algebraic and transcendental equation by Bisection, Newton Raphson and Secant methods	Solution of linear and quadratic equation,

Interpolation by Newton Gregory Forward and Backward difference formula, Error estimation of linear interpolation	Evaluation of trigonometric functions e.g., *sin θ, cos θ, tan θ, etc*
Numerical differentiation (Forward and backward interpolation formula) and Integration (Trapezoidal and Simpson rules), Monte Carlo method	Given Position with equidistant time data to calculate velocity and acceleration and vice versa. Find the area of B-H Hysteresis loop

Recommended readings:

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

Mode of Assessment/ Assessment Tools (%)

Internal: 50

Assignment /Presentation/ attendance/ Class room interaction/quiz etc.: 25
Written Test for theory and/or Viva Voce for Laboratory: 25

Final (End Semester): 50

Written Test for theory and/or Laboratory experiments: 50

Expected Learner Outcomes: This course will

1. Develop the requisite mathematical skills of a student to understand the fundamental topics in Physics.
2. Develop the ability of a student to critically analyze a topic.
3. Prepare a student for more advanced topics in Physics by providing a solid grip over the fundamental concepts in Physics.
4. Demonstrate the use and importance of computational methods in Physics and enable a student to construct a Physics problem computationally.

Course code: **STUGP/C02**
Course title: MECHANICS
Nature of the course: Core
Total Credit assigned: 06
Distribution of credit: Theory – 04, Practicals-02

Objective of the course: At the completion of this course, a student will be able to

1. Understand the basic concepts and ideas in mechanics- e.g., motion, force and torque, mass and moment of inertia, linear and angular momentum, kinetic energy and potential energy etc. by parallel studies of linear dynamics and rotational dynamics.
2. Understand the basic conservation laws by studying them in various mechanical systems including collisions, oscillations, gravitational systems etc.
3. Analyze simple harmonic oscillator in detail
4. Study planetary motions as a central force problem.
5. Understand the concept of frame of reference, importance of relative transformations and invariance of laws of Physics.
6. Realize the consequences of non-inertial frame in our real physical world.
7. Know about the peculiar phenomena of special relativity which are not seen in Newtonian relativity and to understand the concept of space-time.

MECHANICS (THEORY)
60 Lectures, 60 Marks

Fundamentals of Dynamics:
Reference frames. Inertial frames; Review of Newton's Laws of Motion. Galilean transformations; Galilean invariance. Momentum of variable-mass system: motion of rocket. Motion of a projectile in Uniform gravitational field Dynamics of a system of particles. Centre of Mass. Principle of conservation of momentum. Impulse.
(6 Lectures, 6 Marks)

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.

(4 Lectures, 4 Marks)

Collisions:

Elastic and inelastic collisions between particles. Centre of Mass and laboratory frame

(3 Lectures, 3 Marks)

Rotational Dynamics:

Angular momentum of particles and system of particles, Torque. Principle of conservation of angular momentum. Rotation about a fixed axis. Moment of Inertia. Calculation of moment of inertia for rectangular, cylindrical and spherical bodies. Kinetic energy of rotation. Motion involving both translation and rotation.

(12 Lectures, 12 Marks)

Elasticity:

Relation between Elastic constants. Twisting torque on a Cylinder or Wire.

(2 Lectures, 2 Marks)

Fluid Motion:

Kinematics of Moving Fluids: Poiseuille's Equation for Flow of a Liquid through a Capillary Tube.

(3 Lectures, 3 Marks)

Gravitation and Central Force Motion:

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

Motion of a particle under a central force field. Two-body problem and its reduction to one-body problem and its solution. The energy equation and energy diagram. Kepler's Laws. Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system (GPS).

(9 Lectures, 9 Marks)

Oscillations:

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

(7 Lectures, 7 Marks)

Non-Inertial Systems:

Non-inertial frames and fictitious forces. Uniformly rotating frame. Laws of Physics in rotating coordinate systems. Centrifugal force. Coriolis force and its applications. Components of Velocity and Acceleration in Cylindrical and Spherical Coordinate Systems.

(4 Lectures, 4 Marks)

Special Theory of Relativity:

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

(10 Lectures, 10 Marks)

Recommended readings:

- An introduction to Mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.
- Mechanics, Berkeley Physics, vol.1, C. Kittel, W. Knight, et.al. 2007, Tata McGraw-Hill.
- Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.
- Analytical Mechanics, G.R. Fowles and G.L. Cassiday. 2005, Cengage Learning.
- Feynman Lectures, Vol. I, R.P. Feynman, R.B. Leighton, M. Sands, 2008, Pearson Education
- Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

Additional Recommended readings:

- Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000
- University Physics. F.W Sears, M.W Zemansky, H.D Young 13/e, 1986, Addison Wesley
- Physics for scientists and Engineers with Modern Phys., J.W. Jewett, R.A. Serway, 2010, Cengage Learning.
- Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.

Mode of Assessment/ Assessment Tools (%)

Internal:	**40**	
Assignment /Presentation/ attendance/ Class room interaction/quiz etc:		20
Written Test for theory and/or Viva Voce for Laboratory:		20
Final (End Semester):	**60**	
Written Test for theory and/or Laboratory experiments:		60

MECHANICS (LAB)
60 Lectures

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) **g** 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).
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.

Recommended readings:

- Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Edn, 2011, Kitab Mahal
- Engineering Practical Physics, S. Panigrahi & B. Mallick, 2015, Cengage Learning India Pvt. Ltd.
- Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.

Mode of Assessment/ Assessment Tools (%)

Internal:	**50**	
Assignment /Presentation/ attendance/ Class room interaction/quiz etc:		25
Written Test for theory and/or Viva Voce for Laboratory:		25
Final (End Semester):	**50**	
Written Test for theory and/or Laboratory experiments:		50

Expected learner outcome: This course will

1. Introduce the students to the basic concepts of mechanics.
2. Enable the students to understand conservation laws as they are the fundamental laws of nature and will help them in realizing a crucial phenomenon of nature- symmetry.
3. Enable the students to understand simple harmonic oscillator as it is a unique mechanical problem and will help them to understand the advanced treatment in quantum mechanics and

modern Physics.

4. Develop knowledge of special relativity to understand relativistic formulation of modern theories.

5. Develop knowledge of mechanics which will help students in their everyday life.

Semester II

Course code: STUGP/C03
Course title: ELECTRICITY AND MAGNETISM
Nature of the course: Core
Total Credit assigned: 06
Distribution of credit: Theory -04, Practical-02

Course Objective: At the completion of this course, a student will be able to:

1. Gain basic knowledge of electricity and magnetism.
2. Understand the electrical and magnetic properties of matter in brief.
3. Understand the effect of electric field on magnetic field and the effect of magnetic field on current.
4. Understand the basic principle of the electrical circuit (AC) circuit and electrical networking.
5. Acquire the basic theoretical as well as experimental skill on electrical networking.

PHYSICS-C III: ELECTRICITY AND MAGNETISM (THEORY)
60 Lectures, 60 Marks

Electric Field and Electric Potential
Electric field: Electric field lines. Electric flux. Gauss' Law with applications to charge distributions with spherical, cylindrical and planar symmetry.
(6 Lectures, 6 Marks)

Conservative nature of Electrostatic Field. Electrostatic Potential. Laplace's and Poisson equations. The Uniqueness Theorem. Potential and Electric Field of a dipole. Force and Torque on a dipole.
(6 Lectures, 6 Marks)

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

Dielectric Properties of Matter:
Electric Field in matter. Polarization, Polarization Charges. Electrical Susceptibility and Dielectric Constant. Capacitor (parallel plate, spherical, cylindrical) filled with dielectric. Displacement vector **D**. Relations between **E**, **P** and **D**. Gauss' Law in dielectrics.
(8 Lectures, 8 Marks)

Magnetic Field:
Magnetic force between current elements and definition of Magnetic Field **B**. Biot-Savart's Law and its simple applications: straight wire and circular loop. Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole). 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.
(9 Lectures, 9 Marks)

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

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

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

Network theorems:
Ideal Constant-voltage and Constant-current Sources. Network Theorems: Thevenin theorem, Norton theorem, Superposition theorem, Reciprocity theorem, Maximum Power Transfer theorem. Applications to dc circuits.
(4 Lectures, 4 Marks)

Ballistic Galvanometer:
Torque on a current Loop. Ballistic Galvanometer: Current and Charge Sensitivity. Electromagnetic damping. Logarithmic damping. CDR.
(3 Lectures, 3 Marks)

Recommended readings:

- Electricity, Magnetism & Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw
- Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education
- Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn., 1998, Benjamin Cummings.
- Feynman Lectures Vol.2, R.P. Feynman, R.B. Leighton, M. Sands, 2008, Pearson Education

- Elements of Electromagnetics, M.N.O. Sadiku, 2010, Oxford University Press.
- Electricity and Magnetism, J.H. Fewkes & J. Yarwood. Vol. I, 1991, Oxford Univ. Press

Mode of Assessment/ Assessment Tools (%)

Internal: 40

Assignment /Presentation/ attendance/ Class room interaction/quiz etc: 20

Written Test for theory and/or Viva Voce for Laboratory: 20

Final (End Semester): 60

Written Test for theory and/or Laboratory experiments: 60

ELECTRICITY AND MAGNETISM LAB
60 Lectures

1. Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, (d) Capacitances, and (e) Checking electrical fuses.
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 capacitances 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, (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.

Recommended readings:

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
- A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- Engineering Practical Physics, S. Panigrahi and B. Mallick, 2015, Cengage Learning.
- A Laboratory Manual of Physics for undergraduate classes, D.P. Khandelwal, 1985, Vani Pub.

Mode of Assessment/ Assessment Tools (%)

Internal:	**50**	
Assignment /Presentation/ attendance/ Class room interaction/quiz etc.:		25
Written Test for theory and/or Viva Voce for Laboratory:		25
Final (End Semester):	**50**	
Written Test for theory and/or Laboratory experiments:		50

Expected learner outcome: This course will:

1. Develop the basic theoretical knowledge as well as experimental skills of the students on electrical networking.
2. Train the students to handle and repair instruments based on electric and magnetic field effects.

Course code: STUGP/C04
Course title: WAVES AND OPTICS
Nature of the course: Core
Total Credit assigned: 06
Distribution of credit: Theory -04, Practical-02

Course Objective: At the completion of this course, a student will be able to

1. Learn the basics of wave motion.
2. Know about the behavior of light due to its wave nature.
3. Identify and understand different phenomena due to the interaction of light with light and matter.
4. Analyze some of the fundamental laws and principles of light which is used in many important optical instruments.

WAVES AND OPTICS (THEORY)
60 Lectures, 60 Marks

Wave Optics: Electromagnetic nature of light. Definition and properties of wave front.
Huygens Principle. Temporal and Spatial Coherence.
(5 Lectures, 10 Marks)

Interference: Division of amplitude and wavefront. Young's double slit experiment.
Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings:
Measurement of wavelength and refractive index.
(15 Lectures, 15 Marks)

Interferometer: Michelson Interferometer-(1) Idea of form of fringes (No theory required), (2) Determination of Wavelength, (3) Wavelength Difference, (4) Refractive Index, and (5) Visibility of Fringes. Fabry-Perot interferometer.
(10 Lectures, 10 Marks)

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

Fresnel Diffraction: Fresnel's Assumptions. Fresnel's Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Fresnel's Integral, Cornu`s spiral and its applications. Straight edge, a slit and a wire.
(15, Lectures, 15 Marks)

Recommended readings:

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

Mode of Assessment/ Assessment Tools (%)

Internal:	**40**	
Assignment /Presentation/ attendance/ Class room interaction/quiz etc:		20
Written Test for theory and/or Viva Voce for Laboratory:		20
Final (End Semester):	**60**	
Written Test for theory and/or Laboratory experiments:		60

WAVES AND OPTICS (LAB)
60 Lectures

1. To determine the frequency of an electric tuning fork by Melde's experiment and verify λ^2 –T law.
2. To investigate the motion of coupled oscillators.
3. To study Lissajous Figures.
4. Familiarization with: Schuster`s focusing; determination of angle of prism.
5. To determine refractive index of the Material of a prism using sodium source.
6. To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.
7. To determine the wavelength of sodium source using Michelson's interferometer.
8. To determine wavelength of sodium light using Fresnel 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.

Recommended readings:

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

Mode of Assessment/ Assessment Tools (%)

Internal:	**50**	
Assignment /Presentation/ attendance/ Class room interaction/quiz etc.:		25
Written Test for theory and/or Viva Voce for Laboratory:		25
Final (End Semester):	**50**	
Written Test for theory and/or Laboratory experiments:		50

Expected learner outcome: This course will

1. Enable the students to analyze different phenomena due to the interaction of light with light and matter.
2. Train the students to use different optical instruments.
3. Help the students to understand various natural phenomena using different apparatus in the laboratory.

Semester III

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Course Code: S T U G P / C 0 5
Course Title: MATHEMATICAL PHYSICS – II
Nature of the Course: Core
Total Credits assigned: 06
Distribution of credit: Theory – 04, Practicals-02

Course Objectives: At the completion of this course, a student will be able to

1. Write a problem in Physics (slightly more advanced than those in Mathematical Physics I) in the language of Mathematics.
2. Identify a range of diverse mathematical techniques to formulate and solve a problem in basic Physics.
3. Analyze some of the useful mathematical methods.
4. Apply the knowledge and understanding of these mathematical methods to solve problems in a number of fundamental topics in Physics.
5. Construct a problem in Physics computationally.

MATHEMATICAL PHYSICS-II (THEORY)
60 Lectures, 60 Marks

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. Complex representation of Fourier series. Expansion of functions with arbitrary period. Expansion of non-periodic functions over an interval. Even and odd functions and their Fourier expansions. Application. Summing of Infinite Series. Term-by-Term differentiation and integration of Fourier Series. Parseval Identity.
(12 Lectures, 12 Marks)

Frobenius Method and Special Functions:
Singular Points of Second Order Linear Differential Equations and their importance. Frobenius method and its applications to differential equations. Legendre, Bessel, Hermite and Laguerre Differential Equations. Properties of Legendre Polynomials: Rodrigues Formula, Generating Function, Orthogonality. Simple recurrence relations. Expansion of function in a series of Legendre Polynomials. Bessel Functions of the First Kind: Generating Function, simple recurrence relations. Zeros of Bessel Functions (Jo(x) and J1(x)) and Orthogonality.
(24 Lectures, 24 Marks)

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

Functions. Error Function (Probability Integral).
(4 Lectures, 4 Marks)

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.
(6 Lectures, 6 Marks)

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, rectangular and circular membranes. Diffusion Equation. **(14 Lectures, 14 Marks)**

Recommended readings:

- Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier.
- Fourier Analysis by M.R. Spiegel, 2004, Tata McGraw-Hill.
- Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole.
- Differential Equations, George F. Simmons, 2006, Tata McGraw-Hill.
- Partial Differential Equations for Scientists & Engineers, S.J. Farlow, 1993, Dover Pub.
- Engineering Mathematics, S. Pal and S.C. Bhunia, 2015, Oxford University Press
- Mathematical methods for Scientists & Engineers, D.A. McQuarrie, 2003, Viva Books

Mode of Assessment/ Assessment Tools (%)

Internal:	**40**	
Assignment /Presentation/ attendance/ Class room interaction/quiz etc:		20
Written Test for theory and/or Viva Voce for Laboratory:		20
Final (End Semester):	**60**	
Written Test for theory and/or Laboratory experiments:		60

MATHEMATICAL PHYSICS-II (LAB)
60 Lectures

This course will consist of lectures (both theory and practical) in the Lab. Evaluation is to be done not on the programming but on the basis of formulating the problems

Topics	Description with application
Introduction to Numerical computation software SCILAB	Introduction to Scilab, Advantages and disadvantages, Scilab environment, Command window, Figure window, Edit window, Variables and arrays, Initialising variables in Scilab, Multidimensional arrays, Sub array, Special values, Displaying output data, data file, Scalar and array operations, Hierarchy of operations, Built in Scilab functions, Introduction to plotting, 2D and 3D plotting (2), 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 (2) 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 (2) 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 (2).
Curve fitting, Least square fit, Goodness of fit, standard deviation	Ohms law to calculate R, Hooke's law to calculate spring constant
Solutions of linear systems of equations by Gauss elimination method and Gauss Seidal method, Diagonalization of matrices, Inverse of matrix, Eigen vectors, eigen value problem	Solution of mesh equation of electric circuits (3 meshes) Solution of coupled spring mass systems (3 masses)

Recommended readings:

- Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press
- Complex Variables, A.S. Fokas & M.J. Ablowitz, 8th Ed., 2011, Cambridge Univ. Press
- First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940, Jones & Bartlett
- Computational Physics, D. Walker, 1st Edn., 2015, Scientific International Pvt. Ltd.
- A Guide to MATLAB, B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, 2014, 3rd Edn., Cambridge University Press
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A.V. Wouwer, P. Saucez, C.V. Fernández. 2014 Springer
- Scilab by example: M. Affouf 2012, ISBN: 978-1479203444
- Scilab (A free software to Matlab): H. Ramchandran, A.S. Nair. 2011 S. Chand & Company
- Scilab Image Processing: Lambert M. Surhone. 2010 Betascript Publishing
- www.**scilab**.in/textbook_companion/generate_book/291

Mode of Assessment/ Assessment Tools (%)

Internal: 50

Assignment /Presentation/ attendance/ Class room interaction/quiz etc: 25

Written Test for theory and/or Viva Voce for Laboratory: 25

Final (End Semester): 50

Written Test for theory and/or Laboratory experiments: 50

Expected learner Outcomes: This course will:

1. Develop the requisite mathematical skills to understand some of the fundamental topics (slightly more advanced than those in Mathematical Physics I) in Physics.
2. Develop the ability of a student to critically analyze a topic.
3. Prepare a student for more advanced topics in Physics by providing a solid grip over the fundamental concepts in Physics.
4. Enable a student to understand the use and importance of computational / numerical methods in Physics and enable a student to construct a Physics problem computationally.

Course Code: STUGP/C06

Course Title: THERMAL PHYSICS
Nature of the Course: Core
Total Credits assigned: 06
Distribution of credit: Theory – 04, Practicals-02

Course Objectives: At the completion of this course, a student will be able to

1. Develop knowledge on the classical laws of thermodynamics and their application
2. Use the knowledge of thermodynamics in various applications in allied fields like Materials science, Condensed matter Physics, Atmospheric Physics, Solar Physics, etc.
3. Probe questions in varied fields of Physics, chemistry and biology based on principles of Thermal Physics.
4. Use the concept of thermodynamics in real world experiences
5. Develop critical and analytical thinking of the student on thermodynamics and allied disciplines

THERMAL PHYSICS (THEORY)
60 Lectures, 60 Marks

Introduction to Thermodynamics

Zeroth and First Law of Thermodynamics: Extensive and intensive Thermodynamic Variables, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics & Concept of Temperature, Concept of Work & Heat, State Functions, First Law of Thermodynamics and its differential form, Internal Energy, First Law & various processes, Applications of First Law: General Relation between CP and CV, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Co-efficient.
(8 Lectures, 8 Marks)

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

Entropy:
Concept of Entropy, Clausius Theorem. Clausius Inequality, Second Law of Thermodynamics in terms of Entropy. Entropy of a perfect gas. Principle of Increase of Entropy. Entropy Changes in Reversible and Irreversible processes with examples. Entropy of the Universe. Entropy Changes in Reversible and Irreversible Processes. Principle of Increase of Entropy. Temperature–Entropy

diagrams for Carnot's Cycle. Third Law of Thermodynamics. Unattainability of Absolute Zero.
(7 Lectures, 7 Marks)

Thermodynamic Potentials:
Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy. Their Definitions, 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

(7 Lectures, 7 Marks)

Maxwell's Thermodynamic Relations:
Derivations and applications of Maxwell's Relations, Maxwell's Relations:(1) Clausius Clapeyron equation, (2) Values of C_p-C_v, (3) TdS Equations, (4) Joule-Kelvin coefficient for Ideal and Van der Waal Gases, (5) Energy equations, (6) Change of Temperature during Adiabatic Process.
(7 Lectures, 7 Marks)

Kinetic Theory of Gases

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

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

(4 Lectures, 4 Marks)

Real Gases:
Behavior of Real Gases: Deviations from the Ideal Gas Equation. The Virial Equation. Andrew's Experiments on CO_2 Gas. Critical Constants. Continuity of Liquid and Gaseous State. Vapour and Gas. Boyle Temperature. Van der Waal's Equation of State for Real Gases. Values of Critical Constants. Law of Corresponding States. Comparison with Experimental Curves. P-V Diagrams. Joule's Experiment. Free Adiabatic Expansion of a Perfect Gas. Joule-Thomson Porous Plug Experiment. Joule- Thomson Effect for Real and Van der Waal Gases. Temperature of Inversion. Joule- Thomson Cooling.

(10 Lectures, 10 Marks)

Recommended readings:

- Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill.
- A Treatise on Heat, Meghnad Saha, and B.N. Srivastava, 1958, Indian Press
- Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill
- Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.
- Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa.
- Concepts in Thermal Physics, S.J. Blundell and K.M. Blundell, 2nd Ed., 2012, Oxford University Press

Mode of Assessment/ Assessment Tools (%)

Internal:	**40**	
Assignment /Presentation/ attendance/ Class room interaction/quiz etc:		20
Written Test for theory and/or Viva Voce for Laboratory:		20
Final (End Semester):	**60**	
Written Test for theory and/or Laboratory experiments:		60

THERMAL PHYSICS (LAB)
60 Lectures

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

Recommended readings:

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

Mode of Assessment/ Assessment Tools (%)

Internal:	**50**	
Assignment /Presentation/ attendance/ Class room interaction/quiz etc.:		25
Written Test for theory and/or Viva Voce for Laboratory:		25
Final (End Semester):	**50**	
Written Test for theory and/or Laboratory experiments:		50

Expected Learner Outcomes: This course will enable the students to

1. Apply the laws of thermodynamics in real world problems.
2. Conduct scientific problems and experiments on thermodynamics and allied disciplines.
3. Demonstrate a working knowledge of the physical principles in Thermal Physics.

Course Code: S T U G P / C 0 7
Course Title: DIGITAL SYSTEMS AND APPLICATIONS
Nature of the Course: Core
Total Credits assigned: 06
Distribution of credit: Theory – 04, Practicals-02

Course objectives: At the completion of this course, a student will be able to:

1. Know about the basic laboratory equipment electronics.
2. Understand basic digital electronics concepts and devices.
3. Analyze digital circuits.

DIGITAL SYSTEMS AND APPLICATIONS (THEORY)
60 Lectures, 60 Marks

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.
(3 Lectures, 3 Marks)

Integrated Circuits
(Qualitative treatment only): Active & Passive components. Discrete components. Wafer. Chip. Advantages and drawbacks of ICs. Scale of integration: SSI, MSI, LSI and VLSI (basic idea and definitions only). Classification of ICs. Examples of Linear and Digital ICs.
(3 Lectures, 3 Marks)

Digital Circuits:
Difference between Analog and Digital Circuits. Binary Numbers. Decimal to Binary and Binary to Decimal Conversion. BCD, Octal and Hexadecimal numbers. AND, OR and NOT Gates (realization using Diodes and Transistor). NAND and NOR Gates as Universal Gates. XOR and XNOR Gates and application as Parity Checkers.
(6 Lectures, 6 Marks)

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

Data processing circuits:
Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders.
(4 Lectures, 4 Marks)

Arithmetic Circuits:
Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders. Half & Full Subtractors, 4-bit binary Adder/Subtractor.
(5 Lectures, 5 Marks)

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

Timers:
IC 555: block diagram and applications: A stable multivibrator and Monostable multivibrator.
(3 Lectures, 3 Marks)

Shift registers:
Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel-in-Parallel-out Shift Registers (only up to 4 bits).
(2 Lectures, 2 Marks)

Counters (4 bits):
Ring Counter. Asynchronous counters, Decade Counter. Synchronous Counter.
(4 Lectures, 4 Marks)

Computer Organization:
Input/Output Devices. Data storage (idea of RAM and ROM). Computer memory. Memory organization & addressing. Memory Interfacing. Memory Map.
(6 Lectures, 6 Marks)

Intel 8085 Microprocessor Architecture:
Main features of 8085. Block diagram. Components. Pin-out diagram. Buses. Registers. ALU. Memory. Stack memory. Timing & Control circuitry. Timing states. Instruction cycle, Timing diagram of MOV and MVI.
(8 Lectures, 8 Marks)

Introduction to Assembly Language: 1 byte, 2 byte & 3-byte instruction
(4 Lectures, 4 Marks)

Recommended readings:

- Digital Principles and Applications, A.P. Malvino, D.P. Leach and Saha, 7th Ed., 2011, Tata McGraw
- Fundamentals of Digital Circuits, Anand Kumar, 2nd Edn, 2009, PHI Learning Pvt. Ltd.
- Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
- Digital Electronics G K Kharate ,2010, Oxford University Press

- Digital Systems: Principles & Applications, R.J. Tocci, N.S. Widmer, 2001, PHI Learning
- Logic circuit design, Shimon P. Vingron, 2012, Springer.
- Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
- Digital Electronics, S.K. Mandal, 2010, 1st edition, McGraw Hill
- Microprocessor Architecture Programming & applications with 8085, 2002, R.S. Goankar, Prentice Hall.

Mode of Assessment/ Assessment Tools (%)

Internal: 40

Assignment /Presentation/ attendance/ Class room interaction/quiz etc: 20

Written Test for theory and/or Viva Voce for Laboratory: 20

Final (End Semester): 60

Written Test for theory and/or Laboratory experiments: 60

LAB
60 Lectures

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 I.C.
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, IC
14. To design an astable multivibrator of given specifications using 555 Timer.
15. To design a monostable multivibrator of given specifications using 555 Timer.
16. Write the following programs using 8085 Microprocessor
    a) Addition and subtraction of numbers using direct addressing mode
    b) Addition and subtraction of numbers using indirect addressing mode
    c) Multiplication by repeated addition.
    d) Division by repeated subtraction.
    e) Handling of 16-bit Numbers.
    f) Use of CALL and RETURN Instruction.
    g) Block data handling.
    h) Other programs (e.g., Parity Check, using interrupts, etc.).

Recommended readings:

- Modern Digital Electronics, R.P. Jain, 4th Edition, 2010, Tata McGraw Hill.
- Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.
- Microprocessor Architecture Programming and applications with 8085, R.S. Goankar, 2002, Prentice Hall.
- Microprocessor 8085: Architecture, Programming and interfacing, A. Wadhwa, 2010, PHI Learning.

Mode of Assessment/ Assessment Tools (%)

Internal:	**50**	
Assignment /Presentation/ attendance/ Class room interaction/quiz etc.:		25
Written Test for theory and/or Viva Voce for Laboratory:		25
Final (End Semester):	**50**	
Written Test for theory and/or Laboratory experiments:		50

Semester IV

- -

Course Code: S T U G P / C 0 8
Course Title: MATHEMATICAL PHYSICS-III
Nature of the Course: Core
Total Credits assigned: 06
Distribution of credits: Theory – 04, Practicals-02

Course Objectives: At the completion of this course, a student will be able to

1. Write a problem in Physics (slightly more advanced than those in Mathematical Physics I and II) in the language of mathematics.
2. Identify a range of diverse mathematical techniques/ideas to formulate, simplify and solve some problems in Physics.
3. Analyze some of the useful mathematical ideas and techniques.
4. Apply the knowledge and understanding of these mathematical methods to solve problems in a number of fundamental topics in Physics.
5. Construct a problem in Physics computationally and use simulations to design an experiment.

MATHEMATICAL PHYSICS-III (THEORY)
60 Lectures, 60 Marks

Complex Analysis:
Brief Revision of Complex Numbers and their Graphical Representation. Euler's formula, De Moivre's theorem, Roots of Complex Numbers. Functions of Complex Variables. Analyticity and Cauchy-Riemann Conditions. Examples of analytic functions. Singular functions: poles and branch points, order of singularity, branch cuts. 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.
(30 Lectures, 30 Marks)

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.). Three dimensional Fourier transforms with examples. Application of Fourier Transforms to differential equations: One dimensional Wave and Diffusion/Heat Flow Equations.
(15 Lectures, 15 Marks)

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

Theorem. Inverse LT. Application of Laplace Transforms to 2nd order Differential Equations: Damped Harmonic Oscillator, Simple Electrical Circuits, Coupled differential equations of 1st order. Solution of heat flow along infinite bar using Laplace transform.
(15 Lectures, 15 Marks)

Recommended readings:

- Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press
- Mathematics for Physicists, P. Dennery and A. Krzywicki, 1967, Dover Publications
- Complex Variables, A.S. Fokas & M.J. Ablowitz, 8th Ed., 2011, Cambridge Univ. Press
- Complex Variables, A.K. Kapoor, 2014, Cambridge Univ. Press
- Complex Variables and Applications, J.W. Brown & R.V. Churchill, 7th Ed. 2003, Tata McGraw-Hill
- First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940, Jones & Bartlett

Mode of Assessment/ Assessment Tools (%)

Internal:	**40**	
Assignment /Presentation/ attendance/ Class room interaction/quiz etc:		20
Written Test for theory and/or Viva Voce for Laboratory:		20
Final (End Semester):	**60**	
Written Test for theory and/or Laboratory experiments:		60

MATHEMATICAL PHYSICS-III (LAB)
60 Lectures
Scilab/C++ based simulations experiments based on Mathematical Physics problems like:

1. Calculation of error for each data point of observations recorded in experiments done in previous semesters (choose any two).
2. Calculation of least square fitting manually without giving weightage to error. Confirmation of least square fitting of data through computer program.
3. Evaluation of trigonometric functions e.g., $\sin\theta$, 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.
4. Compute the n^{th} roots of unity for $n = 2, 3,$ and 4.
5. Find the two square roots of $-5+12j$.
6. Solve Kirchoff's Current law for any node of an arbitrary circuit using Laplace's transform.
7. Solve Kirchoff's Voltage law for any loop of an arbitrary circuit using Laplace's transform.
8. Perform circuit analysis of a general LCR circuit using Laplace's transform.

Recommended readings:

- Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press
- Mathematics for Physicists, P. Dennery and A. Krzywicki, 1967, Dover Publications
- Complex Variables, A.S. Fokas & M.J. Ablowitz, 8th Ed., 2011, Cambridge Univ. Press
- Complex Variables, A.K. Kapoor, 2014, Cambridge Univ. Press
- Complex Variables and Applications, J.W. Brown & R.V. Churchill, 7th Ed. 2003, Tata McGraw-Hill
- First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940, Jones & Bartlett

Mode of Assessment/ Assessment Tools (%)

Internal:	**50**
Assignment /Presentation/ attendance/ Class room interaction/quiz etc.:	25
Written Test for theory and/or Viva Voce for Laboratory:	25
Final (End Semester):	**50**
Written Test for theory and/or Laboratory experiments:	50

Expected learner Outcomes: This course will

1. Develop mathematical skills of a student to understand some of the fundamental topics (slightly more advanced than those in Mathematical Physics I and II).
2. Develop the ability of a student to critically analyze a topic.

3. Prepare a student for more advanced topics in Physics by providing a solid grip over the fundamental concepts in Physics.
4. Enable a student to understand the use and importance of computational/ numerical methods in Physics and to construct a problem computationally.
5. Help a student to pursue advanced studies in Physics.

Course Code: S T U G P / C 0 9
Course Title: ELEMENTS OF MODERN PHYSICS
Nature of the Course: Core
Total Credits Assigned: 06
Distribution of credits: Theory – 04, Practicals-02

Course Objectives: At the completion of this course, a student will be able to

1. Understand the theoretical basis for the understanding of quantum Physics as the basis for dealing with microscopic phenomena.
2. Apply concepts of 20^{th} Century Modern Physics to deduce the structure of atoms.
3. Explain the wave-particle duality of the photon.
4. Analyze the structure of matter at its most fundamental.
5. Develop insight into the key principles and applications of Nuclear Physics

ELEMENTS OF MODERN PHYSICS (THEORY)
60 Lectures, 60 Marks

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.
(14 Lectures, 14 Marks)
Position measurement- gamma ray microscope thought experiment; Wave-particle duality, Heisenberg uncertainty principle (Uncertainty relations involving Canonical pair of variables): Derivation from Wave Packets impossibility of a particle following a trajectory; Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle- application to virtual particles and range of an interaction.
(5 Lectures, 5 Marks)

Two slit interference experiment with photons, atoms and particles; linear superposition principle as a consequence; Matter waves and wave amplitude; Schrodinger equation for non-relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of a wave function, probabilities and normalization; Probability and probability current densities in one dimension.
(10 Lectures, 10 Marks)

One dimensional infinitely rigid box- energy eigen values and eigen functions, normalization; Quantum dot as example; Quantum mechanical scattering and tunneling in one dimension-across a step potential & rectangular potential barrier.
(10 Lectures, 10 Marks)

Size and structure of atomic nucleus and its relation with atomic weight; Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle. Nature of nuclear force, NZ graph, Liquid Drop model: semi-empirical mass formula and binding energy, Nuclear Shell Model and magic

numbers.
(6 Lectures, 6 Marks)

Radioactivity: stability of the nucleus; Law of radioactive decay; Mean life and half-life; Alpha decay; Beta decay- energy released, spectrum and Pauli's prediction of neutrino; Gamma ray emission, energy-momentum conservation: electron-positron pair creation by gamma photons in the vicinity of a nucleus.

(8 Lectures, 8 Marks)

Fission and fusion- mass deficit, relativity and generation of energy; Fission - nature of fragments and emission of neutrons. Nuclear reactor: slow neutrons interacting with Uranium 235; Fusion and thermonuclear reactions driving stellar energy (brief qualitative discussions).
(3 Lectures, 3 Marks)

Lasers:
Einstein's A and B coefficients. Metastable states. Spontaneous and Stimulated emissions. Optical Pumping and Population Inversion. Three-Level and Four-Level Lasers. Ruby Laser and He-Ne Laser. Basic lasing.

(4 Lectures, 4 Marks)

Recommended Readings:

- Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
- Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGraw Hill
  Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.
- Physics for scientists and Engineers with Modern Physics, Jewett and Serway, 2010, Cengage Learning.
- Modern Physics, G. Kaur and G.R. Pickrell, 2014, McGraw Hill
- Quantum Mechanics: Theory & Applications, A.K. Ghatak & S. Loganathan, 2004, Macmillan

Additional recommended readings:

- Modern Physics, J.R. Taylor, C.D. Zafiratos, M.A. Dubson, 2004, PHI Learning.
- Theory and Problems of Modern Physics, Schaum`s outline, R. Gautreau and W. Savin, 2nd Edn, Tata McGraw-Hill Publishing Co. Ltd.
- Quantum Physics, Berkeley Physics, Vol.4. E.H. Wichman, 1971, Tata McGraw-Hill Co
- Basic ideas and concepts in Nuclear Physics, K. Heyde, 3rd Edn., Institute of Physics Pub.
- Six Ideas that Shaped Physics: Particle Behave like Waves, T.A. Moore, 2003, McGraw Hill

Mode of Assessment/ Assessment Tools (%)

Internal: 40

Assignment /Presentation/ attendance/ Class room interaction/quiz etc: 20

Written Test for theory and/or Viva Voce for Laboratory: 20

Final (End Semester): 60

Written Test for theory and/or Laboratory experiments: 60

ELEMENTS OF MODERN PHYSICS (LAB)
60 Lectures

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.

Mode of Assessment/ Assessment Tools (%)

Internal:	**50**
Assignment /Presentation/ attendance/ Class room interaction/quiz etc:	25
Written Test for theory and/or Viva Voce for Laboratory:	25
Final (End Semester):	**50**
Written Test for theory and/or Laboratory experiments:	50

Expected learner outcome: This course will enable the students to**:**

1. Understand and appreciate the theory of modern physics
2. Develop the ability to apply it in solving simple problems in Quantum Mechanics (QM), structure of atoms, Laser, and Nuclear Physics.

Course Code: S T U G P / C 1 0
Course Title: ANALOG SYSTEMS AND APPLICATIONS
Nature of the Course: Core
Total credits assigned: 06
Distribution of credits: Theory – 04, Practicals-02

Course Objectives: At the completion of this course, a student will be able to

1. Know about the basics of semiconductor PN junction, its various types and its application to different electronic circuits.
2. Understand bipolar junction transistor and its applications as amplifier and oscillators.
3. Familiarize with operational amplifiers, its applications and analysis.
4. Develop knowledge about analog to digital and digital to analog conversion techniques

ANALOG SYSTEMS AND APPLICATIONS (THEORY)
60 Lectures, 60 Marks

Semiconductor Diodes:
P and N type semiconductors. Energy Level Diagram. Conductivity and Mobility, Concept of Drift velocity. PN Junction Fabrication (Simple Idea). Barrier Formation in PN Junction Diode. Static and Dynamic Resistance. Current Flow Mechanism in Forward and Reverse Biased Diode. Drift Velocity. Derivation for Barrier Potential, Barrier Width and Current for Step Junction. Current Flow Mechanism in Forward and Reverse Biased Diode.
(10 Lectures, 10 Marks)

Two-terminal Devices and their Applications:
(1) Rectifier Diode: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, C-filter (2) Zener Diode and Voltage Regulation. Principle and structure of (1) LEDs, (2) Photodiode and (3) Solar Cell.
(6 Lectures, 6 Marks)

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.
(6 Lectures, 6 Marks)

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

Coupled amplifiers:

Two stage RC coupled Amplifier and its frequency response.

(4 Lectures, 4 Marks)

Feedback in Amplifiers:

Effect of positive and negative feedback on Input impedence, Output impedence, Gain, Stability, Distortion and noise.

(4 Lectures, 4 Marks)

Sinusoidal Oscillators:

Barkhausen's Criterion for self-sustained oscillations. RC Phase shift oscillator, determination of Frequency. Hartley & Colpitts oscillators.

(4 Lectures, 4 Marks)

Operational Amplifiers (Black Box approach):

Characteristics of an Ideal and Practical Op-Amp. (IC 741) Open-loop and Closed-loop Gain. Frequency Response. CMRR. Slew Rate and concept of Virtual ground.

(4 Lectures, 4 Marks)

Applications of Op-Amps:

(1) Inverting and non-inverting amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator, (5) Integrator, (6) Log amplifier, (7) Zero crossing detector (8) Wein bridge oscillator.

(9 Lectures, 9 Marks)

Conversion:

Resistive network (Weighted and R-2R Ladder). Accuracy and Resolution. A/D Conversion (successive approximation)

(3 Lectures, 3 Marks)

Recommended readings:

- Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
- Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
- Solid State Electronic Devices, B.G. Streetman & S.K. Banerjee, 6th Edn.,2009, PHI Learning
- Electronic Devices & circuits, S. Salivahanan & N.S. Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill
- OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall
- Microelectronic circuits, A.S. Sedra, K.C. Smith, A.N. Chandorkar, 2014, 6th Edn., Oxford University Press.
- Electronic circuits: Handbook of design & applications, U. Tietze, C. Schenk, 2008, Springer
- Semiconductor Devices: Physics and Technology, S.M. Sze, 2nd Ed., 2002, Wiley India
- Microelectronic Circuits, M.H. Rashid, 2nd Edition, Cengage Learning
- Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India

Mode of Assessment/ Assessment Tools (%)

Internal: 40

Assignment /Presentation/ attendance/ Class room interaction/quiz etc: 20

Written Test for theory and/or Viva Voce for Laboratory: 20

Final (End Semester): 60

Written Test for theory and/or Laboratory experiments: 60

ANALOG SYSTEMS AND APPLICATIONS (LAB)

60 Lectures

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 an op-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.
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.

Recommended readings:

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

Mode of Assessment/ Assessment Tools (%)

Internal:	**50**	
Assignment /Presentation/ attendance/ Class room interaction/quiz etc.:		25
Written Test for theory and/or Viva Voce for Laboratory:		25
Final (End Semester):	**50**	
Written Test for theory and/or Laboratory experiments:		50

Expected Learner Outcomes: This course will enable the students to

1. Learn the foundation knowledge of analog electronic systems.
2. Learn the working and applications of PN junction and bipolar junction transistors (BJT).
3. Learn to analyze circuits containing PN junction and BJT along with the application of BJT as amplifiers and oscillators.
4. Develop basic knowledge of operational amplifier and its applications

Semester V

Course Code: S T U G P / C 1 1
Course Title: QUANTUM MECHANICS AND APPLICATIONS
Nature of the Course: Core
Total credits assigned: 06
Distribution of credits: Theory – 04, Practicals-02

Course Objectives: At the completion of this course, a student will be able to

1. Know about the development of modern Physics and the theoretical formulation of quantum mechanics.
2. Know the applications of quantum mechanics in solving physical problems.

QUANTUM MECHANICS AND APPLICATIONS (THEORY)
60 Lectures, 60 Marks

Time dependent Schrodinger equation:
Time dependent Schrodinger equation and dynamical evolution of a quantum state; Properties of Wave Function. Interpretation of Wave Function Probability and probability current densities in three dimensions; Conditions for Physical Acceptability of Wave Functions. Normalization. Linearity and Superposition Principles. Eigenvalues and Eigenfunctions. Position, momentum and Energy operators; commutator of position and momentum operators; Expectation values of position and momentum. Wave Function of a Free Particle.
(6 Lectures, 6 Marks)

Time independent Schrodinger equation-
Hamiltonian, 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 in terms of linear combinations of stationary states; Application to spread of Gaussian wave-packet for a free particle in one dimension; wave packets, Fourier transforms and momentum space wavefunction; Position-momentum uncertainty principle.
(10 Lectures, 10 Marks)

General discussion of bound states in an arbitrary potential-
continuity of wave function, boundary condition and emergence of discrete energy levels; application to one-dimensional problem-square well potential; Quantum mechanics of simple harmonic oscillator-energy levels and energy eigen functions using Frobenius method; Hermite polynomials; ground state, zero-point energy & uncertainty principle.
(12 Lectures, 12 Marks)

Quantum theory of hydrogen-like atoms:

time independent Schrodinger equation in spherical polar coordinates; separation of variables for second order partial differential equation; angular momentum operator & quantum numbers; Radial wave functions from Frobenius method; shapes of the probability densities for ground & first excited states; Orbital angular momentum quantum numbers l and m; s, p, d... shells.

(10 Lectures, 10 Marks)

Atoms in Electric & Magnetic Fields:

Electron angular momentum. Space quantization. Electron Spin and Spin Angular Momentum. Larmor's Theorem. Spin Magnetic Moment. Stern-Gerlach Experiment. Zeeman Effect: Electron Magnetic Moment and Magnetic Energy, Gyromagnetic Ratio and Bohr Magneton.

(8 Lectures, 8 Marks)

Atoms in External Magnetic Fields: -

Normal and Anomalous Zeeman Effect. Paschen Back and Stark Effect (Qualitative Discussion only).

(4 Lectures, 4 Marks)

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, 10 Marks)

Recommended readings:

- A Text book of Quantum Mechanics, P.M. Mathews and K. Venkatesan, 2^{nd} Ed., 2010, McGraw Hill
- Quantum Mechanics, Robert Eisberg and Robert Resnick, 2^{nd} Edn., 2002, Wiley.
- Quantum Mechanics, Leonard I. Schiff, 3^{rd} Edn. 2010, Tata McGraw Hill.
- Quantum Mechanics, G. Aruldhas, 2^{nd} Edn. 2002, PHI Learning of India.
- Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning.
- Quantum Mechanics: Foundations & Applications, Arno Bohm, 3^{rd} Edn., 1993, Springer
- Quantum Mechanics for Scientists & Engineers, D.A.B. Miller, 2008, Cambridge University Press

Additional recommended readings:

- Quantum Mechanics, Eugen Merzbacher, 2004, John Wiley and Sons, Inc.
- Introduction to Quantum Mechanics, D.J. Griffith, 2^{nd} Ed. 2005, Pearson Education
- Quantum Mechanics, Walter Greiner, 4^{th} Edn., 2001, Springe

Mode of Assessment/ Assessment Tools (%)

Internal: 40

Assignment /Presentation/ attendance/ Class room interaction/quiz etc: 20

Written Test for theory and/or Viva Voce for Laboratory: 20

Final (End Semester): 60

Written Test for theory and/or Laboratory experiments: 60

QUANTUM MECHANICS AND APPLICATIONS (LAB)
60 Lectures

Laboratory based experiments:

1. Study of Electron spin resonance- determine magnetic field as a function of the resonance frequency
2. Study of Zeeman effect: with external magnetic field; Hyperfine splitting
3. To show the tunneling effect in tunnel diode using I-V characteristics.
4. Quantum efficiency of CCDs

Recommended readings:

- Schaum's outline of Programming with C++. J. Hubbard, 2000, McGraw‐Hill Publication
- Numerical Recipes in C: The Art of Scientific Computing, W.H. Pressetal., 3rd Edn., 2007, Cambridge University Press.
- An introduction to computational Physics, T. Pang, 2nd Edn.,2006, Cambridge Univ. Press
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific & Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández.2014 Springer.
- Scilab (A Free Software to Matlab): H. Ramchandran, A.S. Nair. 2011 S. Chand & Co.
- A Guide to MATLAB, B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, 2014, 3rd Edn., Cambridge University Press
- Scilab Image Processing: L.M. Surhone.2010 Betascript Publishing ISBN:978-6133459274

Mode of Assessment/ Assessment Tools (%)

Internal:	**50**	
Assignment /Presentation/ attendance/ Class room interaction/quiz etc.:		25
Written Test for theory and/or Viva Voce for Laboratory:		25
Final (End Semester):	**50**	
Written Test for theory and/or Laboratory experiments:		50

Expected Learner Outcomes: This course will enable students to

1. Learn how to apply quantum mechanics to solve physical systems in different areas of science.
2. Know about the physical behavior of materials.
3. Learn how the scientific behavior of materials can be used for human applications.

Course Code: STUGP/C12
Course Title: SOLID STATE PHYSICS
Nature of the Course: Core
Total credits assigned: 06
Distribution of credits: Theory – 04, Practicals-02

Course Objectives: At the completion of this course, a student will be able to

1. Familiarize with fundamentals of Solid-State Physics.
2. Know about the structural, electronic and lattice vibration dependent behavior of solids.
3. Learn the basic concepts in hands on mode through laboratory experiments associated with the course.

SOLID STATE PHYSICS (THEORY)
60 Lectures, 60 Marks

Crystal Structure:
Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis – Central and Non-Central Elements. Unit Cell. Miller Indices. Reciprocal Lattice. Types of Lattices. Brillouin Zones. Diffraction of X-rays by Crystals. Bragg's Law. Atomic and Geometrical Factor. **(12 Lectures, 12 Marks)**

Elementary Lattice Dynamics:
Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains. Acoustical and Optical Phonons. Qualitative Description of the Phonon Spectrum in Solids. Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids. T^3 law
(10 Lectures, 10 Marks)

Magnetic Properties of Matter:
Dia-, Para-, Ferri- and Ferromagnetic Materials. Classical Langevin Theory of dia– and Paramagnetic Domains. Quantum Mechanical Treatment of Paramagnetism. Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss. **(8 Lectures, 8 Marks)**

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. Optical Phenomena. Application: Plasma Oscillations, Plasma Frequency, Plasmons, TO modes.

(8 Lectures, 8 Marks)

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, 6 Marks)

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, 10 Marks)

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, 6 Marks)

Recommended readings:

- Introduction to Solid State Physics, Charles Kittel, 8th Edition, 2004, Wiley India Pvt. Ltd.
- Elements of Solid-State Physics, J.P. Srivastava, 4th Edition, 2015, Prentice-Hall of India
- Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill
- Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning
- Solid-state Physics, H. Ibach and H. Luth, 2009, Springer
- Solid State Physics, Rita John, 2014, McGraw Hill
- Elementary Solid-State Physics, 1/e M. Ali Omar, 1999, Pearson India
- Solid State Physics, M.A. Wahab, 2011, Narosa Publications

Mode of Assessment/ Assessment Tools (%)

Internal:	**40**	
Assignment /Presentation/ attendance/ Class room interaction/quiz etc:		20
Written Test for theory and/or Viva Voce for Laboratory:		20
Final (End Semester):	**60**	
Written Test for theory and/or Laboratory experiments:		60

SOLID STATE PHYSICS (LAB)
60 Lectures

1. Measurement of susceptibility of paramagnetic solution (Quinck`s Tube Method)
2. To measure the Magnetic susceptibility of Solids.
3. To determine the Coupling Coefficient of a Piezoelectric crystal.
4. To measure the Dielectric Constant of a dielectric Materials with frequency
5. To determine the complex dielectric constant and plasma frequency of metal using Surface Plasmon resonance (SPR)
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 ^{o}C) and to determine its band gap.
10. To determine the Hall coefficient of a semiconductor sample.
11. To determine the band gap of semiconductor by P-N junction method.

Recommended readings:

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
- A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
- Elements of Solid-State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India.

Mode of Assessment/ Assessment Tools (%)

Internal:	**50**
Assignment /Presentation/ attendance/ Class room interaction/quiz etc.:	25
Written Test for theory and/or Viva Voce for Laboratory:	25
Final (End Semester):	**50**
Written Test for theory and/or Laboratory experiments:	50

Expected Learner Outcome: The course will

1. Equip a student with basic concepts of solid-state Physics so that the knowledge can be applied for further development of the subject.
2. Enable a student to work in both theoretical and experimental aspects of solid-state Physics.
3. Help the students in thorough learning of the concepts associated to the course through the laboratory experiments.

Semester VI

Course Code: S T U G P / C 1 3
Course Title: ELECTROMAGNETIC THEORY
Nature of the Course: Core
Total credits assigned: 06
Distribution of credits: Theory – 04, Practicals-02

Course Objectives: At the completion of this course, a student will be able to

1. Understand the physical and mathematical principles to provide in-depth analysis of the behavior of electricity and magnetism in matter.
2. Apply Maxwell's equations to explain the properties of the electromagnetic wave and its interaction with matter.
3. Analyze the principles and processes related to polarization, interference, and diffraction along with their applications to the development of wave-guide and optical fibers.

ELECTROMAGNETIC THEORY (THEORY)
60 Lectures, 60 Marks

Maxwell Equations:
Review of 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. Electromagnetic (EM) Energy Density. Physical Concept of Electromagnetic Field Energy Density, Momentum Density and Angular Momentum Density.
(12 Lectures, 12 Marks)

EM Wave Propagation in Unbounded Media:
Plane EM waves through vacuum and isotropic dielectric medium, transverse nature of plane EM waves, refractive index and dielectric constant, wave impedance. Propagation through conducting media, relaxation time, skin depth. Wave propagation through dilute plasma, electrical conductivity of ionized gases, plasma frequency, refractive index, skin depth, application to propagation through ionosphere.
(10 Lectures, 10 Marks)

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

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

(12 Lectures, 12 Marks)

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.

(5 Lectures, 5 Marks)

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, 8 Marks)

Optical Fibres:

Numerical aperture, Step and Graded Indices (Definitions only), Single and Multimode fibres (Concepts and Definition Only).

(3 Lectures, 3 Marks)

Recommended readings:

- Introduction to Electrodynamics, D.J. Griffiths, 3rd Ed., 1998, Benjamin Cummings.
- Elements of Electromagnetics, M.N.O. Sadiku, 2001, Oxford University Press.
- Introduction to Electromagnetic Theory, T.L. Chow, 2006, Jones & Bartlett Learning
- Fundamentals of Electromagnetics, M.A.W. Miah, 1982, Tata McGraw Hill
- Electromagnetic field Theory, R.S. Kshetrimayun, 2012, Cengage Learning
- Engineering Electromagnetic, Willian H. Hayt, 8th Edition, 2012, McGraw Hill.
- Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer

Additional recommended readings:

- Electromagnetic Fields & Waves, P. Lorrain & D. Corson, 1970, W.H. Freeman & Co.
- Electromagnetics, J.A. Edminster, Schaum Series, 2006, Tata McGraw Hill.
- Electromagnetic field theory fundamentals, B. Guru and H. Hiziroglu, 2004, Cambridge University Press

Mode of Assessment/ Assessment Tools (%)

Internal:	**40**	
Assignment /Presentation/ attendance/ Class room interaction/quiz etc:		20
Written Test for theory and/or Viva Voce for Laboratory:		20
Final (End Semester):	**60**	
Written Test for theory and/or Laboratory experiments:		60

ELECTROMAGNETIC THEORY (LAB)
60 Lectures

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.

Recommended readings:

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4^{th} Edition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11^{th} Ed., 2011, Kitab Mahal
- Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer

Mode of Assessment/ Assessment Tools (%)

Internal:	**50**	
Assignment /Presentation/ attendance/ Class room interaction/quiz etc.:		25
Written Test for theory and/or Viva Voce for Laboratory:		25
Final (End Semester):	**50**	
Written Test for theory and/or Laboratory experiments:		50

Expected learner Outcomes: This course will enable a student to

1. Solve problems relevant to interfaces between media with defined boundary conditions.
2. Use Maxwell's equations to describe the behaviour of electromagnetic waves in vacuum as well as medium.
3. Describe states and methods of polarization and analyze the polarization state of a light source.

Course Code: S T U G P / C 1 4
Course Title: STATISTICAL MECHANICS
Nature of the Course: Core
Total credits assigned: 06
Distribution of credits: Theory – 04, Practicals-02

Course objectives:

The Statistical Mechanics is one of the most important branches of Physics which is required to understand the properties of matter in bulk on the basis of the dynamical behaviors of its microscopic constituents. As such the objectives of this course are to

1. Introduce the basic concepts of Statistical Mechanics so that students will be able to cope-up with higher level of such course in future.
2. Develop the critically thinking ability of students to understand the diverse physical phenomena.
3. Develop the interest and ability among students to solved challenging physical problems by the application of techniques of Statistical Mechanics in future.

STATISTICAL MECHANICS (THEORY)
60 Lectures, 60 Marks

Classical Statistics:

Macrostate & Microstate, Elementary Concept of Ensemble, Phase Space, 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, 18 Marks)**

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, 9 Marks)**

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, 5 Marks)**

Bose-Einstein Statistics:

B-E distribution law, Thermodynamic functions of a strongly Degenerate Bose Gas, Bose Einstein condensation, properties of liquid He (qualitative description), Radiation as a photon gas and

Thermodynamic functions of photon gas. Bose derivation of Planck's law.
(13 Lectures, 13 Marks)

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, 15 Marks)

Recommended readings:

- Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.
- Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill
- Statistical and Thermal Physics, S. Lokanathan and R.S. Gambhir. 1991, Prentice Hall
- Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.
- Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer
- An Introduction to Statistical Mechanics & Thermodynamics, R.H. Swendsen, 2012, Oxford Univ. Press

Mode of Assessment/ Assessment Tools (%)

Internal:	**40**	
Assignment /Presentation/ attendance/ Class room interaction/quiz etc:		20
Written Test for theory and/or Viva Voce for Laboratory:		20
Final (End Semester):	**60**	
Written Test for theory and/or Laboratory experiments:		60

STATISTICAL MECHANICS (LAB)
60 Lectures

Use C/C^{++}/Scilab/other numerical simulations for solving the problems based on Statistical Mechanics like

1. Computational analysis of the behavior of a collection of particles in a box that satisfy Newtonian mechanics and interact via the Lenard-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 C_v, depend upon the temperature, total number of particles N and the spectrum of single particle states.
    b) Ratios of occupation numbers of various states for the systems considered above
    c) Computation of physical quantities at large and small temperature T and comparison of various statistics at large and small temperature T.

3. Plot Planck's law for Black Body radiation and compare it with Raleigh-Jeans Law at high temperature and low temperature.

4. Plot Specific Heat of Solids (a) Dulong-Petit law, (b) Einstein distribution function, (c) Debye distribution function for high temperature and low temperature and compare them for these two cases.

5. Plot the following functions with energy at different temperatures

    a) Maxwell-Boltzmann distribution
    b) Fermi-Dirac distribution
    c) Bose-Einstein distribution

Recommended readings:

- Elementary Numerical Analysis, K.E. Atkinson, 3rd Edn. 2007, Wiley India Edition
- Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.
- Introduction to Modern Statistical Mechanics, D. Chandler, Oxford University Press, 1987
- Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.
- Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer
- Statistical and Thermal Physics with computer applications, Harvey Gould and Jan Tobochnik, Princeton University Press, 2010.
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández. 2014 Springer ISBN: 978-3319067896
- Scilab by example: M. Affouf, 2012. ISBN: 978-1479203444
- Scilab Image Processing: L.M. Surhone. 2010, Betascript Pub., ISBN: 978- 6133459274

Mode of Assessment/ Assessment Tools (%)

Internal:	**50**	
Assignment /Presentation/ attendance/ Class room interaction/quiz etc.:		25
Written Test for theory and/or Viva Voce for Laboratory:		25
Final (End Semester):	**50**	
Written Test for theory and/or Laboratory experiments:		50

Expected Learner Outcome: This course will

1. Equip the students with basic knowledge of the Statistical Mechanics and hence will be able to look critically for analyzing any physical phenomena.
2. Create interest to the subject to pursue further higher study in future.
3. Enable the students to solve any challenging physical problem in statistical mechanics

DISCIPLINE SPECIFIC ELECTIVES (DSE)

Semester V

Course code: STUGP/DSE01
Course title: CLASSICAL DYNAMICS
Nature of the course: DSE
Total credit assigned: 06
Distribution of credits: Theory – 05, Tutorials-01

Course objective: After completing the course, a student will be able to

1. Understand the underlying facts in the development of classical mechanics and the advantages of its formulation over Newtonian mechanics.
2. Describe mechanics of a system in terms of equation of motion.
3. Understand Lagrangian formulation and Hamiltonian formulation of mechanics and their applications in mechanical problems.
4. Study the theoretical analysis of systems oscillating with small amplitudes.
5. Observe the peculiar phenomena when transformed from Newtonian relativity to special relativity and to understand the concept of space-time.

CLASSICAL DYNAMICS (THEORY)
75 Lectures, 60 Marks

Classical Mechanics of Point Particles:
Review of Newtonian Mechanics; Application to the motion of a charge particle in external electric and magnetic fields- motion in uniform electric field, magnetic field- gyroradius and gyrofrequency, motion in crossed electric and magnetic fields. Generalized coordinates and velocities, Hamilton's principle, Lagrangian and the Euler-Lagrange equations, one-dimensional examples of the Euler-Lagrange equations- one-dimensional Simple Harmonic Oscillations and falling body in uniform gravity; applications to simple systems such as coupled oscillators Canonical momenta & Hamiltonian. Hamilton's equations of motion.

Applications: Hamiltonian for a harmonic oscillator, solution of Hamilton's equation for Simple Harmonic Oscillations; particle in a central force field- conservation of angular momentum and energy.
(22 Lectures, 20 Marks)

Small Amplitude Oscillations:

Minima of potential energy and points of stable equilibrium, expansion of the potential energy around a minimum, small amplitude oscillations about the minimum, normal modes of oscillations example of N identical masses connected in a linear fashion to (N -1) - identical springs.

(10 Lectures, 10 Marks)

Special Theory of Relativity:

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. 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.

(33 Lectures, 20 Marks)

Fluid Dynamics:

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

(10 Lectures, 10 Marks)

Recommended readings:

- Classical Mechanics, H. Goldstein, C.P. Poole, J.L. Safko, 3rd Edn. 2002, Pearson Education.
- Mechanics, L. D. Landau and E. M. Lifshitz, 1976, Pergamon.
- Classical Electrodynamics, J.D. Jackson, 3rd Edn., 1998, Wiley.
- The Classical Theory of Fields, L.D Landau, E.M Lifshitz, 4th Edn., 2003, Elsevier.
- Introduction to Electrodynamics, D.J. Griffiths, 2012, Pearson Education.
- Classical Mechanics, P.S. Joag, N.C. Rana, 1st Edn., McGraw Hall.
- Classical Mechanics, R. Douglas Gregory, 2015, Cambridge University Press.
- Classical Mechanics: An introduction, Dieter Strauch, 2009, Springer.
- Solved Problems in classical Mechanics, O.L. Delange and J. Pierrus, 2010, Oxford Press

Mode of Assessment/ Assessment Tools (%)

Internal:	**40**
Assignment /Presentation/ attendance/ Class room interaction/quiz etc.:	20
Written Test for theory and/or Viva Voce for Laboratory:	20
Final (End Semester):	**60**
Written Test for theory and/or Laboratory experiments:	60

Expected learner outcome: This course will enable the students to

1. Prepare for the study of modern Physics.
2. Develop basic theoretical ingredients necessary to study advanced theoretical courses like quantum mechanics.
3. Learn a number of mathematical techniques applicable to Physics problems in different areas.
4. Develop knowledge of special relativity which is essential to understand the relativistic formulation of modern theories.

Course code: STUGP/DSE02
Course title: NUCLEAR AND PARTICLE PHYSICS
Nature of the course: DSE
Total credit assigned: 06
Distribution of credits: Theory – 05, Tutorial -01

Course Objective: After the end of the course, a student will be able to

1. Understand various concepts in Nuclear Physics.
2. Emphasize on the existing connections with other domains of Physics, in particular Quantum Mechanics, Mathematical Physics and Particle Physics.

NUCLEAR AND PARTICLE PHYSICS (THEORY)
75 Lectures, 60 Marks

General Properties of Nuclei:
Constituents of nucleus and their Intrinsic properties, quantitative facts about mass, radii, charge density (matter density), binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve, N/A plot, angular momentum, parity, magnetic moment, electric moments, nuclear excites states.
(10 Lectures, 10 Marks)

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.
(12 Lectures, 10 Marks)

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, electron capture, neutrino hypothesis. (c) Gamma decay: Gamma rays' emission & kinematics, internal conversion. (**10 Lectures, 10 Marks**)

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, 5 Marks)
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.

(8 Lectures, 5 Marks)

Detector for Nuclear Radiations:

Gas detectors: estimation of electric field, mobility of particle, for ionization chamber and GM Counter. Basic principle of Scintillation Detectors and construction of photo-multiplier tube (PMT). Semiconductor Detectors (Si and Ge) for charge particle and photon detection (concept of charge carrier and mobility), neutron detector.

(8 Lectures, 5 Marks)

Particle Accelerators:

Accelerator facility available in India: Van-de Graaff generator (Tandem accelerator), Linear accelerator, Cyclotron, Synchrotrons.

(5 Lectures, 5 Marks)

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.

(14 Lectures, 10 Marks)

Recommended readings:

- Introductory nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).
- Concepts of nuclear Physics by Bernard L. Cohen. (Tata McGraw Hill, 1998).
- Introduction to the Physics of nuclei & particles, R.A. Dunlap. (Thomson Asia, 2004).
- Introduction to High Energy Physics, D.H. Perkins, Cambridge Univ. Press
- Introduction to Elementary Particles, D. Griffith, John Wiley & Sons
- Quarks and Leptons, F. Halzen and A.D. Martin, Wiley India, New Delhi
- Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K. Heyde (IOP-Institute of Physics Publishing, 2004).
- Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).
- Physics and Engineering of Radiation Detection, Syed Naeem Ahmed (Academic Press, Elsevier, 2007).
- Theoretical Nuclear Physics, J.M. Blatt & V.F. Weisskopf (Dover Pub.Inc., 1991)

Mode of Assessment/ Assessment Tools (%)

Internal: 40

Assignment /Presentation/ attendance/ Class room interaction/quiz etc.: 20

Written Test for theory and/or Viva Voce for Laboratory: 20

Final (End Semester): 60

Written Test for theory and/or Laboratory experiments: 60

Expected learner outcome: This course will enable the students to

1. Develop knowledge regarding nuclear and elementary particle as well as properties and phenomena related to them.
2. Successfully apply the same knowledge in solving problems in the field of nuclear and particle Physics.

Course code: STUGP/DSE03
Course title: ASTRONOMY AND ASTROPHYSICS
Nature of the course: DSE
Total credit assigned: 06
Distribution of credits: Theory – 05, Tutorials-01

Course Objectives: Astrophysics (and Astronomy) is the most fascinating and rapidly growing field of Physics at present. In fact, Astronomy is the oldest science among all physical sciences. Although in recent years due to sophistication of theoretical as well as observational techniques this field of Physics grows unprecedentedly, still there are lots of regions of this field which are remained unexplored till now.
Thus, the objectives of offering this course are to

1. Introduce the fundamental concepts of Astrophysics to the interested students.
2. Motivate students to pursue the further study in future in these challenging, fascinating and important fields of Physics.

ASTRONOMY & ASTROPHYSICS (THEORY)
75 Lectures, 60 Marks

Astronomical Scales:
Astronomical Distance, Mass and Time, Scales, Brightness, Radiant Flux and Luminosity, Measurement of Astronomical Quantities Astronomical Distances, Stellar Radii, Masses of Stars, Stellar Temperature.
(4 Lectures, 2 Marks)

Basic concepts of positional astronomy:
Celestial Sphere, Geometry of a Sphere, Spherical Triangle Astronomical Coordinate Systems, Geographical Coordinate Systems, Horizon System, Equatorial System, Diurnal Motion of the Stars, Conversion of Coordinates. Measurement of Time, Sidereal Time, Apparent Solar Time, Mean Solar Time, Equation of Time, Calendar. Basic Parameters of Stars: Determination of Distance by Parallax Method; Brightness, Radiant Flux and Luminosity, Apparent and Absolute magnitude scale, Distance Modulus; Determination of Temperature and Radius of a star; Determination of Masses from Binary orbits; Stellar Spectral Classification, Hertzsprung-Russell Diagram.
(20 Lectures, 20 Marks)

Astronomical techniques:
Basic Optical Definitions for Astronomy (Magnification Light Gathering Power, Resolving Power and Diffraction Limit, Atmospheric Windows), Optical Telescopes (Types of Reflecting Telescopes, Telescope Mountings, Space Telescopes, Detectors and Their Use with Telescopes (Types of Detectors, detection Limits with Telescopes).
(6 Lectures, 5 Marks)

Physical principles: Gravitation in Astrophysics (Virial Theorem, Newton versus Einstein), Systems in Thermodynamic Equilibrium.

(3 Lectures, 3 Marks)

The sun

(Solar Parameters, Solar Photosphere, Solar Atmosphere, Chromosphere. Corona, Solar Activity, Basics of Solar Magneto-hydrodynamics. Helioseismology).

The solar family (Solar System: Facts and Figures, Origin of the Solar System: The Nebular Model, Tidal Forces and Planetary Rings, Extra- Solar Planets.

(6 Lectures, 5 Marks)

Stellar spectra and classification Structure (Atomic Spectra Revisited, Stellar Spectra, Spectral Types and Their Temperature Dependence, Black Body Approximation, H R Diagram, Luminosity Classification)

(5 Lectures, 2 Marks)

The milky way:

Basic Structure and Properties of the Milky Way, Nature of Rotation of the Milky Way (Differential Rotation of the Galaxy and Oort Constant, Rotation Curve of the Galaxy and the Dark Matter, Nature of the Spiral Arms), Stars and Star Clusters of the Milky Way, Properties of and around the Galactic Nucleus.

(14 Lectures, 10 Marks)

Galaxies:

Galaxy Morphology, Hubble's Classification of Galaxies, Elliptical Galaxies (The Intrinsic Shapes of Elliptical, de Vaucouleurs Law, Stars and Gas). Spiral and Lenticular Galaxies (Bulges, Disks, Galactic Halo) The Milky Way Galaxy, Gas and Dust in the Galaxy, Spiral Arms.

(7 Lectures, 8 Marks)

Large scale structure & expanding universe:

Cosmic Distance Ladder (An Example from Terrestrial Physics, Distance Measurement using Cepheid Variables), Hubble's Law (Distance- Velocity Relation), Clusters of Galaxies (Virial theorem and Dark Matter).

(10 Lectures, 5 Marks)

Recommended readings:

- Modern Astrophysics, B.W. Carroll & D.A. Ostlie, Addison-Wesley Publishing Co.
- Introductory Astronomy and Astrophysics, M. Zeilik and S.A. Gregory, 4th Edition, Saunders College Publishing.
- The Physical universe: An introduction to astronomy, F. Shu, Mill Valley: University Science Books.
- Fundamental of Astronomy (Fourth Edition), H. Karttunen et al. Springer
- K.S. Krishnasamy, 'Astrophysics a modern perspective,' Reprint, New Age International

(p) Ltd, New Delhi,2002.

- Baidyanath Basu, 'An introduction to Astrophysics', Second printing, Prentice - Hall of India Private limited, New Delhi,2001.
- Textbook of Astronomy and Astrophysics with elements of cosmology, V.B. Bhatia, Narosa Publication.

Mode of Assessment/ Assessment Tools (%)

Internal:	**40**	
Assignment /Presentation/ attendance/ Class room interaction/quiz etc.:		20
Written Test for theory and/or Viva Voce for Laboratory:		20
Final (End Semester):	**60**	
Written Test for theory and/or Laboratory experiments:		60

Expected Learner Outcome: This course will:

1. Equip the students with basic knowledge of the Astrophysics.
2. Create interest to the subjects of Astrophysics and to pursue further higher studies in the subject concerned in future.
3. Develop the critically analyzing ability, which may motivate the students to solve any challenging physical problem in future.

Course code: STUGP/DSE04
Course title: PHYSICS OF EARTH
Nature of the course: DSE
Total credit assigned: 06
Distribution of credits: Theory – 05, Tutorial -01

Course Objectives: After the completion of the course, a student will be able to

1. Acquire knowledge on origin and evolution of the Earth and Universe
2. Acquire knowledge on structure, composition and dynamics of the Earth from crust up to space.
3. Understand the interaction among different components of the Earth.
4. Get familiar with the weather and climate systems, climate change.
5. Increase people awareness of the scientific process of the Earth and its role in the exploration of the Universe.

PHYSICS OF EARTH (THEORY)
75 Lectures, 60 Marks

1. **The Earth and the Universe**:

(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.
(17 Lectures, 14 Marks)

2. **Structure**:

(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. **(18 Lectures, 15 Marks)**

3. **Dynamical Processes**:

a) 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.

b) 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.

c) The Atmosphere: Atmospheric circulation. Weather and climatic changes. Earth's heat budget. Cyclones.

Climate:

i. Earth's temperature and greenhouse effect.
ii. Paleoclimate and recent climate changes.
iii. The Indian monsoon system.

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

(18 Lectures, 14 Marks)

4. Evolution:

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.

1. Time line of major geological and biological events.
2. Origin of life on Earth.
3. Role of the biosphere in shaping the environment.
4. Future of evolution of the Earth and solar system: Death of the Earth.

(18 Lectures, 14 Marks)

5. Disturbing the Earth – Contemporary dilemmas

(a) Human population growth.
(b) Atmosphere: Greenhouse gas emissions, climate change, air pollution.
(c) Hydrosphere: Fresh water depletion.

(d) Geosphere: Chemical effluents, nuclear waste.

(e) Biosphere: Biodiversity loss. Deforestation. Robustness and fragility of ecosystem **(4 Lectures, 3 Marks)**

Recommended readings:

- Planetary Surface Processes, H. Jay Melosh, Cambridge University Press, 2011.
- Consider a Spherical Cow: A course in environmental problem solving, John Harte. University Science Books
- Holme's Principles of Physical Geology. 1992. Chapman & Hall.
- Emiliani, C, 1992. Planet Earth, Cosmology, Geology and the Evolution of Life and Environment. Cambridge University Press.

Mode of Assessment/ Assessment Tools (%)

Internal: 40

Assignment /Presentation/ attendance/ Class room interaction/quiz etc.: 20

Written Test for theory and/or Viva Voce for Laboratory: 20

Final (End Semester): 60

Written Test for theory and/or Laboratory experiments: 60

Expected learner Outcomes: This course will enable the students to:

1. Develop critical and quantitative thinking of scientific issues related to the study of cosmology and Earth Sciences.
2. Understand the basic principles of various processes of the Earth.
3. Apply the acquired knowledge on the study of the Universe
4. Pursue career in Earth Sciences, Cosmology etc.
5. Understand the contemporary dilemmas on Earth and Environmental issues like climate change, air pollution, deforestation etc.

Semester VI

Course code: STUGP/DSE05
Course title: PHYSICS OF DEVICES AND INSTRUMENTS
Nature of the course: DSE
Total credit assigned: 06
Distribution of credits: Theory-04, Practicals-02

Course Objectives: After completing this course, a student will be able to:

1. Know about various devices like UJT, FET, MOSFET, CMOS etc. and its application to different electronic circuits.
2. Design rectifiers, passive and active filters, multivibrators etc.
3. Familiarize with the IC fabrication techniques.
4. Learn about digital data communication standards and also about communication systems.

PHYSICS OF DEVICES AND INSTRUMENTS (THEORY)
60 Lectures, 60 Marks

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, 14 Marks)

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.
Active and Passive Filters, Low Pass, High Pass, Band Pass and band Reject Filters.
Multivibrators: As table and Monostable Multivibrators using transistors.
(9 Lectures, 9 Marks)

Phase Locked Loop (PLL): Basic Principles, 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, 5 Marks)

Processing of Devices:
Basic process flow for IC fabrication, Electronic grade silicon. Crystal plane and orientation. Defects in the lattice. Oxide layer. Oxidation Technique for Si. Metallization technique. Positive and Negative Masks. Optical lithography. Electron lithography. Feature size control and wet anisotropic etching. Lift off Technique. Diffusion and implantation.
(12Lectures, 12 Marks)

Digital Data Communication Standards:
Serial Communications: RS232, Handshaking, Implementation of RS232 on PC.
Universal Serial Bus (USB): USB standards, Types and elements of USB transfers. Devices (Basic idea of UART).
(2 Lectures, 2 Marks)

Parallel Communications: General Purpose Interface Bus (GPIB), GPIB signals and lines, Handshaking and interface management, Implementation of a GPIB on a PC. Basic idea of sending data through a COM port.
(3 Lectures, 3 Marks)

Introduction to communication systems: Block diagram of electronic communication system, Need for modulation. Amplitude modulation. Modulation Index. Analysis of Amplitude Modulated wave. Sideband frequencies in AM wave. CE Amplitude Modulator. Demodulation of AM wave using Diode Detector. basic idea of Frequency, Phase, Pulse and Digital Modulation including ASK, PSK, FSK.
(15 Lectures, 15 Marks)

Recommended readings:

- Physics of Semiconductor Devices, S.M. Sze & K.K. Ng, 3rd Ed.2008, John Wiley & Sons
- Electronic devices and integrated circuits, A.K. Singh, 2011, PHI Learning Pvt. Ltd.
- Op-Amps & Linear Integrated Circuits, R.A. Gayakwad,4 Ed. 2000, PHI Learning Pvt. Ltd
- Electronic Devices and Circuits, A. Mottershead, 1998, PHI Learning Pvt. Ltd.
- Electronic Communication systems, G. Kennedy, 1999, Tata McGraw Hill.
- Introduction to Measurements & Instrumentation, A.K. Ghosh, 3rd Ed., 2009, PHI Learning Pvt. Ltd.
- Semiconductor Physics and Devices, D.A. Neamen, 2011, 4th Edition, McGraw Hill
- PC based instrumentation; Concepts & Practice, N. Mathivanan, 2007, Prentice-Hall of India

Mode of Assessment/ Assessment Tools (%)

Internal: **40**
Assignment /Presentation/ attendance/ Class room interaction/quiz etc: 20
Written Test for theory and/or Viva Voce for Laboratory: 20
Final (End Semester): **60**
Written Test for theory and/or Laboratory experiments: 60

PHYSICS OF DEVICES AND INSTRUMENTS (LAB)
60 Lectures

Experiments from both Section A and Section B:
Section-A

1. To design a power supply using bridge rectifier and study effect of C-filter.
2. To design the active Low pass and High pass filters of given specification.
3. To design the active filter (wide band pass and band reject) of given specification.
4. To study the output and transfer characteristics of a JFET.
5. To design a common source JFET Amplifier and study its frequency response.
6. To study the output characteristics of a MOSFET.
7. To study the characteristics of a UJT and design a simple Relaxation Oscillator.
8. To design an Amplitude Modulator using Transistor.
9. To design PWM, PPM, PAM and Pulse code modulation using ICs.
10. To design an Astable multivibrator of given specifications using transistor.
11. To study a PLL IC (Lock and capture range).
12. To study envelope detector for demodulation of AM signal.
13. Study of ASK and FSK modulator.
14. Glow an LED via USB port of PC.
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 Norton Theorems.
2. Design and analyze the series and parallel LCR circuits
3. Design the inverting and non-inverting amplifier using an Op-Amp of given gain
4. Design and Verification of op-amp as integrator and differentiator
5. Design the 1^{st} order active low pass and high pass filters of given cutoff frequency
6. Design a Wein`s Bridge oscillator of given frequency.
7. Design clocked SR and JK Flip-Flop`s using NAND Gates
8. Design 4-bit asynchronous counter using Flip-Flop ICs
9. Design the CE amplifier of a given gain and its frequency response.
10. Design an Astable multivibrator using IC555 of given duty cycle.

Recommended readings:

- Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill
- Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
- Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
- OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4^{th} edn., 2000, Prentice Hall.
- Introduction to PSPICE using ORCAD for circuits & Electronics, M.H. Rashid, 2003, PHI Learning.
- PC based instrumentation; Concepts & Practice, N. Mathivanan, 2007, Prentice-Hall of India

Mode of Assessment/ Assessment Tools (%)

Internal: 50

Assignment /Presentation/ attendance/ Class room interaction/quiz etc.: 25

Written Test for theory and/or Viva Voce for Laboratory: 25

Final (End Semester): 50

Written Test for theory and/or Laboratory experiments: 50

Expected learner outcome: This course will enable the students to:

1. Develop knowledge about various devices like UJT, FET etc. and to use these devices for different applications.
2. Design and analyse filter circuits, power supply FET amplifiers etc.
3. Develop the basic knowledge of IC fabrications, data communication standards and communication systems.

Course code: STUGP/DSE06
Course title: NANO MATERIALS AND APPLICATION
Nature of the course: DSE
Total credit assigned: 06
Distribution of credits: Theory – 04, Practical -02

Course Objective: The aim of the course is to

1. Provide a systematic coverage and insight into the promising area of nano materials in order to facilitate the understanding of the nature and prospects for the field.
2. Provide information about various synthesis and characterization techniques of nano materials.
3. Discuss optical and electronic transport properties of nano materials.
4. Discuss applications of nano materials.

NANO MATERIALS AND APPLICATIONS (THEORY)
60 Lectures, 60 Marks

Nanoscale systems:
Length scales in Physics, Nanostructures: 1D, 2D and 3D nanostructures (nanodots, thin films, nanowires, nanorods)**,** Band structure and density of states of materials at nanoscale, Size Effects in nano systems, 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.
(10 Lectures, 10 Marks)

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 dot
(8 Lectures, 8 Marks)

Characterization:
X- ray diffraction, Optical Microscopy, scanning electron Microscopy, Transmission Electron Microscopy, Atomic Force Microscopy, Scanning Tunneling Microscopy
(8 Lectures, 8 Marks)

Optical properties:
Coulomb interaction in nanostructures. Concept of dielectric constant for nanostructures and charging of nanostructure. Quasi-particles and excitons. Excitons in direct and indirect band gap semiconductor nanocrystals. Quantitative treatment of quasi-particles and excitons, charging effects. Radiative Processes: General formalization-absorption, emission and luminescence, Optical properties of hetero structures and nano structures.
(14 Lectures, 14 Marks)

Electron transport:
Carrier transport in nanostrcutures. Coulomb blockade effect, thermionic emission, tunneling and hoping conductivity. Defects and impurities: Deep level and surface defects.
(6 Lectures, 6 Marks)

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)
(14 Lectures, 14 Marks)

Recommended readings:

- C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.).
- S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publishing Company)
- K.K. Chattopadhyay and A. N. Banerjee, Introduction to Nanoscience and Technology (PHI Learning Private Limited).
- Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).
- M. Hosokawa, K. Nogi, M. Naita, T. Yokoyama, Nanoparticle Technology Handbook (Elsevier, 2007).
- Introduction to Nanoelectronics, V.V. Mitin, V.A. Kochelap and M.A. Stroscio, 2011, Cambridge University Press.
- Bharat Bhushan, Springer Handbook of Nanotechnology (Springer-Verlag, Berlin

Mode of Assessment/ Assessment Tools (%)

Internal:	**40**	
Assignment /Presentation/ attendance/ Class room interaction/quiz etc:		20
Written Test for theory and/or Viva Voce for Laboratory:		20
Final (End Semester):	**60**	
Written Test for theory and/or Laboratory experiments:		60

NANO MATERIALS AND APPLICATIONS (LAB)
60 Lectures

1. Synthesis of metal nano particles by chemical route.
2. Synthesis of semiconductor nano particles.
3. Surface Plasmon study of metal nano particles by UV-Visible spectrophotometer.
4. XRD pattern of nano materials and estimation of particle size.
5. To study the effect of size on color of nano materials.
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.

Recommended readings:

- C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.).
- S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publishing Company).
- K.K. Chattopadhyay and A.N. Banerjee, Introduction to Nanoscience & Technology (PHI Learning Private Limited).
- Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).

Mode of Assessment/ Assessment Tools (%)

Internal:	**50**	
Assignment /Presentation/ attendance/ Class room interaction/quiz etc.:		25
Written Test for theory and/or Viva Voce for Laboratory:		25
Final (End Semester):	**50**	
Written Test for theory and/or Laboratory experiments:		50

Expected learner outcome: This course will enable the students to

1. Gather sufficient knowledge about the fascinating behaviour of nanomaterials and tuning of such properties for different applications.
2. Obtain information on experimental methodologies with necessary theoretical background, which may be useful for pursuing further study on the areas of nanoscience and technology.

Course code: STUGP/DSE07
Course title: EXPERIMENTAL TECHNIQUES
Nature of the course: DSE
Total credit assigned: 06
Distribution of credits: Theory – 04, Practicals -02

Course objective: After completing this course, a student will be able to

1. Enhance experimental knowledge.
2. Develop the theoretical as well as experimental knowledge of different instruments and instrumentation.
3. Enhance the knowledge of some measurement techniques and data and error analysis technique.

EXPERIMENTAL TECHNIQUES (THEORY)
60 Lectures, 60 Marks
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. Guassian distribution. **(7 Lectures, 7 Marks)**

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, 7 Marks)

Shielding and Grounding:
Methods of safety grounding. Energy coupling. Grounding. Shielding: Electrostatic shielding. Electromagnetic Interference.
(4 Lectures, 4 Marks)

Transducers & industrial instrumentation (working principle, efficiency, applications):
Static and dynamic characteristics of measurement Systems. Generalized performance of systems, zero order first order, second order and higher order systems. Electrical, Thermal and Mechanical systems. Calibration. Transducers and sensors. Characteristics of Transducers. Transducers as electrical element and their signal conditioning. Temperature transducers: RTD, Thermistor, Thermocouples, Semiconductor type temperature sensors (AD590, LM35, LM75) and signal conditioning. Linear Position transducer: Strain gauge, Piezoelectric. Inductance change transducer: Linear variable differential transformer (LVDT), Capacitance change transducers. Radiation Sensors: Principle of Gas filled detector, ionization chamber, scintillation detector.
(21 Lectures, 21 Marks)

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

Impedance Bridges and Q-meter:
Block diagram and working principles of RLC bridge. Q-meter and its working operation. Digital LCR bridge.
(4 Lectures, 4 Marks)

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 (Pirani, Penning, ionization).
(12 Lectures, 12 Marks)

Recommended readings:

- Measurement, Instrumentation and Experiment Design in Physics and Engineering, M. Sayer and A. Mansingh, PHI Learning Pvt. Ltd.
- Experimental Methods for Engineers, J.P. Holman, McGraw Hill
- Introduction to Measurements and Instrumentation, A.K. Ghosh, 3rd Edition, PHI Learning Pvt. Ltd.
- Transducers and Instrumentation, D.V.S. Murty, 2nd Edition, PHI Learning Pvt. Ltd.
- Instrumentation Devices and Systems, C.S. Rangan, G.R. Sarma, V.S.V. Mani, Tata McGraw Hill
- Principles of Electronic Instrumentation, D. Patranabis, PHI Learning Pvt. Ltd.
- Electronic circuits: Handbook of design & applications, U. Tietze, Ch. Schenk, Springer

Mode of Assessment/ Assessment Tools (%)

Internal:	**40**	
Assignment /Presentation/ attendance/ Class room interaction/quiz etc:		20
Written Test for theory and/or Viva Voce for Laboratory:		20
Final (End Semester):	**60**	
Written Test for theory and/or Laboratory experiments:		60

EXPERIMENTAL TECHNIQUES (LAB)
60 Lectures

1. 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. Calibrate Semiconductor type temperature sensor (AD590, LM35, or LM75)
7. To measure the change in temperature of ambient using Resistance Temperature Device (RTD).
8. 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. 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.

Recommended readings:

- Electronic circuits: Handbook of design and applications, U. Tietze and C. Schenk, 2008, Springer
- Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1990, Mc-Graw Hill
- Measurement, Instrumentation and Experiment Design in Physics & Engineering, M. Sayer and A. Mansingh, 2005, PHI Learning

Mode of Assessment/ Assessment Tools (%)

Internal:	**50**	
Assignment /Presentation/ attendance/ Class room interaction/quiz etc.:		25
Written Test for theory and/or Viva Voce for Laboratory:		25
Final (End Semester):	**50**	
Written Test for theory and/or Laboratory experiments:		50

Expected learner outcome: This course will enable the students to

1. Develop the theoretical as well as experimental knowledge on different instruments and instrumentation.
2. Develop the knowledge of some measurement techniques and data and error analysis technique, which is very essential for a Physics student.
3. Handle different electrical network-based instruments.

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ABILITY ENHANCEMENT ELECTIVE COURSE (AEEC)

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Semester III

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Course code: STUGP/AEEC01
Course title: APPLIED OPTICS
Nature of the course: AEEC
Total credit assigned: 02
Course Objectives: After completing this course, a student will be able to:

1. Learn about various optical devices, components and systems.
2. Familiarize with experiments related to optoelectronic devices.
3. Learn about Fourier transform spectroscopy, holography and various aspects of fibre optics.

PHYSICS AEEC-1: APPLIED OPTICS (THEORY)
30 Lectures, 60 Marks

(i) Sources and Detectors

Lasers, Spontaneous and stimulated emissions, Theory of laser action, Einstein's coefficients, Light amplification, Characterization of laser beam, He-Ne laser, Semiconductor lasers**.**
(9 Lectures, 20 Marks)

Experiments on Lasers:

a. Determination of the grating radial spacing of the Compact Disc (CD) by reflection using He-Ne or solid-state laser.
b. To find the width of the wire or width of the slit using diffraction pattern obtained by a He-Ne or solid-state laser.
c. To find the polarization angle of laser light using polarizer and analyzer
d. Thermal expansion of quartz using laser

Experiments on Semiconductor Sources and Detectors:

a) V-I characteristics of LED
b) Study the characteristic of solid-state laser
c) Study the characteristics of LDR
d) Photovoltaic cell
e) Characteristic of IR sensor

(ii) Fourier optics

Concept of Spatial frequency filtering, Fourier transforming property of a thin lens
(6 Lectures, 15 Marks)

Experiments on Fourier Optics:

a. Fourier optic and image processing

1. Optical image addition/subtraction
2. Optical image differentiation
3. Fourier optical filtering
4. Construction of an optical 4f system

Fourier Transform Spectroscopy

Fourier Transform Spectroscopy (FTS) is a powerful method for measuring emission and absorption spectra, with wide application in atmospheric remote sensing, NMR spectrometry and forensic science.

Experiment:

To study the interference pattern from a Michelson interferometer as a function of mirror separation in the interferometer. The resulting interferogram is the Fourier transform of the power spectrum of the source. Analysis of experimental interferograms allows one to determine the transmission

(iii) Holography

Basic principle and theory: coherence, resolution, Types of holograms, white light reflection hologram, application of holography in microscopy, interferometry, and character recognition
(6 Lectures, 10 Marks)

Experiments on Holography and interferometry:

1. Recording and reconstructing holograms
2. Constructing a Michelson interferometer or a Fabry Perot interferometer
3. Measuring the refractive index of air
4. Constructing a Sagnac interferometer
5. Constructing a Mach-Zehnder interferometer
6. White light Hologram

(iv) Photonics: Fibre optics

Optical fibres and their properties, Principal of light propagation through a fibre, The numerical aperture, Attenuation in optical fibre and attenuation limit, Single mode and multimode fibres, Fibre optic sensors: Fibre Bragg Grating.
(9 Lectures, 15 Marks)

Experiments on Photonics: Fibre Optics

a. To measure the numerical aperture of an optical fibre
b. To study the variation of the bending loss in a multimode fibre
c. To determine the mode field diameter (MFD) of fundamental mode in a single-mode fibre by measurements of its far field Gaussian pattern
d. To measure the near field intensity profile of a fibre and study its refractive index profile
e. To determine the power loss at a splice between two multimode fibres

Recommended readings:

- Fundamental of optics, F. A. Jenkins & H. E. White, 1981, Tata McGraw hill.
- LASERS: Fundamentals & applications, K. Thyagrajan & A.K. Ghatak, 2010, Tata McGraw Hill
- Fibre optics through experiments, M.R. Shenoy, S.K. Khijwania, et.al. 2009, Viva Books
- Nonlinear Optics, Robert W. Boyd, (Chapter-I), 2008, Elsevier.
- Optics, Karl Dieter Moller, Learning by computing with model examples, 2007, Springer.
- Optical Systems and Processes, Joseph Shamir, 2009, PHI Learning Pvt. Ltd.
- Optoelectronic Devices and Systems, S.C. Gupta, 2005, PHI Learning Pvt. Ltd.
- Optical Physics, A. Lipson, S.G. Lipson, H. Lipson, 4th Edn., 1996, Cambridge Univ. Press

Mode of Assessment/ Assessment Tools

Internal:	**40**	
Assignment /Presentation/ attendance/ Class room interaction/quiz etc:		20
Written Test for theory and/or Viva Voce for Laboratory:		20
Final (End Semester):	**60**	
Written Test for theory and/or Laboratory experiments:		60

Expected learner outcome: This course will enable the students to:

1. Acquire knowledge about various optoelectronic devices and their applications.
2. Understand the basics of Laser and their uses.
3. Understand about Fourier transform spectroscopy and will learn to use this technique for various purposes.
4. Learn the use of optical fibres and related information.

Semester IV

Course code: STUGP/AEEC05

Course title: ELECTRICAL CIRCUITS AND NETWORK SKILLS
Nature of the course: AEEC
Total credit assigned: 02

Course Objectives: After the completion of this course, a student will be able to

1. Design and trouble shoot the electrical circuits, networks and appliances through hands on mode.
2. Build the basic foundation for learning electrical wirings and repairing of other house hold equipments.

ELECTRICAL CIRCUITS AND NETWORK SKILLS (THEORY)
30 Lectures, 60 Marks

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, 5 Marks)

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, 10 Marks)

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, 10 Marks)

Generators and Transformers:
DC Power sources. AC/DC generators. Inductance, capacitance, and impedance. Operation of transformers.
(3 Lectures, 5 Marks)

Electric Motors:
Single-phase, three-phase & DC motors. Basic design. Interfacing DC or AC sources to control heater and motors, speed and power of ac motor
(4 lectures, 5 Marks)

Solid state devices:
Resistors, inductors and capacitors, Diode and rectifiers, Components in series or in shunt, Response of Inductors and capacitors with AC or DC sources.
(3 Lectures, 5 Marks)

Electrical Protections:
Relays, fuses and disconnect switches, Circuit breakers, Overload devices. Ground-fault protection. Grounding and isolating. Phase reversal. Surge protection. Interfacing DC or AC sources to control elements (relay protection device)
(4 Lectures, 10 Marks)

Electrical Wiring:
Different types of conductors and cables. Basics of wiring-Star and delta connection. Voltage drops 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: wirenuts, crimps, terminal blocks, split bolts, and solder. Preparation of extension board.
(5 Lectures, 10 Marks)

Recommended readings:

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

Mode of Assessment/ Assessment Tools

Internal:	**40**
Assignment /Presentation/ attendance/ Class room interaction/quiz etc.:	20
Written Test for theory and/or Viva Voce for Laboratory:	20
Final (End Semester):	**60**
Written Test for theory and/or Laboratory experiments:	60

Expected learner outcome: This course will enable the students to

1. Design and troubleshoot certain electrical circuits and domestic appliances along with the understanding of the working of those appliances.
2. Do electrical wiring and repairing. This knowledge will develop the skill of the students for various electrical repairing and servicing purposes.

GENERIC ELECTIVE

Semester I

Course Code: STUGP/GE01

Course Title: MECHANICS
Nature of the Course: GENERIC ELECTIVE
Total Credits assigned: 06
Distribution of credits: Theory – 04, Practicals-02

Course Objective: At the completion of this course, a student will be able to

1. Understand the basics of vector algebra and the techniques of solving ordinary differential equations.
2. Understand the basic components of mechanics- e.g., motion, force and torque, mass and moment of inertia, linear and angular momenta, kinetic energy and potential energy etc. and the conservation theorems.
3. Study the mechanics of gravitational systems and simple harmonic motion.
4. Study the elastic behaviour of materials.
5. Realize the idea of frame of reference and its implications in the study of special relativity.

PHYSICS-GE-1: MECHANICS (THEORY)
60 Lectures, 60 Marks

Vectors:
Vector algebra. Scalar and vector products. Derivatives of a vector with respect to a parameter.
(3 Lectures, 3 Marks)

Ordinary Differential Equations:
1^{st} order homogeneous differential equations. 2^{nd} order homogeneous differential equations with constant coefficients.
(7 Lectures, 7 Marks)

Laws of Motion:
Frames of reference. Newton's Laws of motion. Dynamics of a system of particles. Centre of Mass.
(10 Lectures, 10 Marks)

Momentum and Energy:
Conservation of momentum. Work and energy. Conservation of energy. Motion of rockets.
(6 Lectures, 6 Marks)

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

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.

(8 Lectures, 8 Marks)

Oscillations:

Simple harmonic motion. Differential equation of SHM and its solutions. Kinetic and Potential Energy, Total Energy and their time averages. Damped oscillations.

(6 Lectures, 6 Marks)

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 σ by Searles method.

(8 Lectures, 8 Marks)

Special Theory of Relativity:

Constancy of speed of light. Postulates of Special Theory of Relativity. Length contraction. Time dilation. Relativistic addition of velocities.

(7 Lectures, 7 Marks)

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Recommended readings:

- University Physics. F.W. Sears, M.W. Zemansky and H.D. Young, 13/e, 1986. Addison-Wesley
- Mechanics Berkeley Physics, v.1: Charles Kittel, et. al. 2007, Tata McGraw-Hill.
- Physics – Resnick, Halliday & Walker 9/e, 2010, Wiley
- Engineering Mechanics, Basudeb Bhattacharya, 2nd edn., 2015, Oxford University Press
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

Mode of Assessment/ Assessment Tools

(%) Internal	**40**	
Assignment /Presentation/ attendance/ Class room interaction/quiz etc:		20
Written Test for theory and/or Viva Voce for Laboratory:		20
Final (End Semester):	**60**	
Written Test for theory and/or Laboratory experiments:		60

MECHANICS (LAB)
60 Lectures

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 determine g and velocity for a freely falling body using Digital Timing Technique
10. To study the Motion of a Spring and calculate (a) Spring Constant, (b) g.

Recommended readings:

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4^{th} Edition, reprinted 1985, Heinemann Educational Publishers.
- Engineering Practical Physics, S. Panigrahi & B. Mallick,2015, Cengage Learning India Pvt. Ltd.
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11^{th} Edition, 2011, Kitab Mahal, New Delhi.

Mode of Assessment/ Assessment Tools (%)

Internal:	**50**	
Assignment /Presentation/ attendance/ Class room interaction/quiz etc.:		20
Written Test for theory and/or Viva Voce for Laboratory:		20
Final (End Semester):	**50**	
Written Test for theory and/or Laboratory experiments:		50

Expected learner outcome: This course will enable the students to

1. Develop basic knowledge of mechanics as it is helpful to study any other course in science discipline.
2. Develop knowledge of vector algebra and differential equations which will help students in the study of theoretical courses in science.
3. Acquire useful knowledge about material science.
4. Explain the abstract idea of 4-dimensional world to students which are not from physics discipline.

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Semester II

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Course Code: S T U G P / G E 0 2
Course Title: ELECTRICITY AND MAGNETISM
Nature of the Course: GENERIC ELECTIVE
Total Credits assigned: 06
Distribution of credits: Theory – 04, Practicals-02

Course Objectives: At the completion of this course, a student will be able to:

1. Understand basic knowledge of electricity and magnetism.
2. Understand basic knowledge of electrical and magnetic properties of matter in brief.
3. Understand the basic knowledge of the effect of electric field on magnetic field and the effect of magnetic field on current.
4. Understand the basic principle of the electrical circuit (AC) circuit and electrical networking.
5. Develop the basic theoretical as well as experimental skill on electrical networking.

ELECTRICITY AND MAGNETISM (THEORY)
60 Lectures, 60 Marks

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 of vectors (statement only).
(12 Lectures, 12 Marks)

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. Dielectric medium, Polarisation, Displacement vector. Gauss's theorem in dielectrics. Parallel plate capacitor completely filled with dielectric.
(22 Lectures, 22 Marks)

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, 10 Marks)

Electromagnetic Induction:
Faraday's laws of electromagnetic induction, Lenz's law, self and mutual inductance, L of single coil, M of two coils. Energy stored in magnetic field.
(6 Lectures, 6 Marks)

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, 10 Marks)

Recommended readings:

- Electricity and Magnetism, Edward M. Purcell, 1986, McGraw-Hill Education
- Electricity & Magnetism, J.H. Fewkes & J. Yarwood. Vol. I, 1991, Oxford Univ. Press
- Electricity and Magnetism, D C Tayal, 1988, Himalaya Publishing House.
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
- D.J. Griffiths, Introduction to Electrodynamics, 3rd Edn, 1998, Benjamin Cummings.

Mode of Assessment/ Assessment Tools

(%) Internal:	**40**
Assignment /Presentation/ attendance/ Class room interaction/quiz etc:	20
Written Test for theory and/or Viva Voce for Laboratory:	20
Final (End Semester):	**60**
Written Test for theory and/or Laboratory experiments:	60

ELECTRICITY AND MAGNETISM (LAB)
60 Lectures

1. To use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, and (d) checking electrical fuses.
2. Ballistic Galvanometer:
   (i) Measurement of charge and current sensitivity
   (ii) Measurement of CDR
   (iii) Determine a high resistance by Leakage Method
   (iv) 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 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

Recommended readings:

- Advanced Practical Physics for students, B.L. Flint & H.T. Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed.2011, Kitab Mahal
- Engineering Practical Physics, S. Panigrahi & B. Mallick, 2015, Cengage Learning India Pvt. Ltd.

Mode of Assessment/ Assessment Tools (%)

Internal:	**50**
Assignment /Presentation/ attendance/ Class room interaction/quiz etc.:	25
Written Test for theory and/or Viva Voce for Laboratory:	25
Final (End Semester):	**50**
Written Test for theory and/or Laboratory experiments:	50

Expected learner outcome:

This course will enable the students to

1. Perform quantitative analyses of basic problems in Electrostatics and Magneto dynamics.
2. Apply Gauss's Law, Ampere's Law, and Biot-Savart Law to solving practical problems in electricity and magnetism.
3. Apply the fundamental laws of electromagnetism to solve problems of electrostatics, magnetostatics, and electromagnetic induction

4. Explain and analyze the behaviour of alternating currents in LCR circuits.
5. Perform and interpret the results of simple experiments and demonstrations of physical principles.
6. Solve problems relevant to interfaces between media with defined boundary conditions.

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Semester III

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Course Code: S T U G P / G E 0 3
Course Title: THERMAL PHYSICS AND STATISTICAL MECHANICS
Nature of the Course: GENERIC ELECTIVE
Total Credits assigned: 06
Distribution of credits: Theory – 04, Practicals-02

Course objectives: At the completion of this course, a student will be able to

1. Develop the working knowledge of the laws and methods of thermodynamics and elementary statistical mechanics.
2. Provide insight to the postulates of Statistical Mechanics and statistical interpretation of thermodynamics
3. Understand the laws of radiation and acquire knowledge for their applications in various disciplines in Physics, Chemistry, Biology, Earth and Atmospheric Sciences.
4. Develop application-oriented knowledge on laws of statistical mechanics in selected problems
5. Use the methodologies, conventions and tools of thermal and statistical physics to test and communicate ideas and explanation

THERMAL PHYSICS AND STATISTICAL MECHANICS (THEORY)
(60 Lectures, 60 Marks)

Laws of 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, Entropy changes in reversible & irreversible processes, Entropy-temperature diagrams, Third law of thermodynamics, Unattainability of absolute zero.
(22 Lectures, 22 Marks)

Thermodynamic 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, 10 Marks)

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, 10 Marks)

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.
(6 Lectures, 6 Marks)

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. **(12 Lectures, 12 Marks)**

Recommended readings:

- Thermal Physics, S. Garg, R. Bansal and C. Ghosh, 1993, Tata McGraw-Hill.
- A Treatise on Heat, Meghnad Saha, and B.N. Srivastava, 1969, Indian Press.
- Thermodynamics, Enrico Fermi, 1956, Courier Dover Publications.
- Heat and Thermodynamics, M.W. Zemasky and R. Dittman, 1981, McGraw Hill
- Thermodynamics, Kinetic theory & Statistical thermodynamics, F.W. Sears and G.L. Salinger. 1988, Narosa
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
- Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. Chand Publications.

Mode of Assessment/ Assessment Tools

(%) Internal:	**40**
Assignment /Presentation/ attendance/ Class room interaction/quiz etc:	20
Written Test for theory and/or Viva Voce for Laboratory:	20
Final (End Semester):	**60**
Written Test for theory and/or Laboratory experiments:	60

THERMAL PHYSICS AND STATISTICAL MECHANICS (LAB)
60 Lectures

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 a 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

Recommended readings:

- Advanced Practical Physics for students, B.L. Flint & H.T. Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4^{th} Edition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11^{th} Edition, 2011, Kitab Mahal, New Delhi.
- A Laboratory Manual of Physics for Undergraduate Classes, D.P. Khandelwal,
- 1985, Vani Publication.

Mode of Assessment/ Assessment Tools (%)

Internal:	**50**
Assignment /Presentation/ attendance/ Class room interaction/quiz etc.:	25
Written Test for theory and/or Viva Voce for Laboratory:	25
Final (End Semester):	**50**
Written Test for theory and/or Laboratory experiments:	50

Expected learner Outcomes: This course will enable the students to

1. Apply laws of thermodynamics and statistical mechanics to a range of situations in real world problems.
2. Conduct scientific problems and experiments on thermodynamics and allied disciplines.
3. Demonstrate a working knowledge of the physical principles describing the thermal physics.
4. Explain thermal physics as logical consequences of the postulates of statistical mechanics

Semester IV

Course Code: STUGP/GE04

Course Title: WAVES AND OPTICS
Nature of the Course: GENERIC ELECTIVE
Total Credits assigned: 06
Distribution of credits: Theory – 04, Practicals-02

Course objectives: At the completion of this course, a student will be able to

1. Learn the basic ideas of the behaviour of light based on its wave nature.
2. Develop the knowledge of the different phenomena due to the interaction of light among them and with mater.
3. Learn about some fundamental principles of light which is used in different optical instrument which very essential for Physics student.

WAVES AND OPTICS (THEORY)
60 Lectures, 60 Marks

Superposition of Two Collinear Harmonic oscillations:
Linearity & Superposition Principle. (1) Oscillations having equal frequencies and (2) Oscillations having different frequencies (Beats).
Superposition of Two Perpendicular Harmonic Oscillations:
Graphical and Analytical Methods. Lissajous Figures with equal an unequal frequency and their uses.
(6 Lectures, 6 Marks)

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.,
(7 Lectures, 7 Marks)

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.
(10 Lectures, 10 Marks)

Wave Optics:
Electromagnetic nature of light. Definition and Properties of wave front. Huygens Principle.
(3 Lectures, 3 Marks)

Interference:
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 thickness (Fizeau Fringes). Newton's Rings: measurement of wavelength and refractive index.

Michelson's Interferometer:

Idea of form of fringes (no theory needed), Determination of wavelength, Wavelength difference, Refractive index, and Visibility of fringes.

(15 Lectures, 15 Marks)

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.

(14 Lectures, 14 Marks)

Polarization:

Transverse nature of light waves. Plane polarized light – production and analysis. Circular and elliptical polarization.

(5 Lectures, 5 Marks)

Recommended readings:

- Fundamentals of Optics, F.A Jenkins and H.E White, 1976, McGraw-Hill
- Principles of Optics, B.K. Mathur, 1995, Gopal Printing
- Fundamentals of Optics, H.R. Gulati and D.R. Khanna, 1991, R. Chand Publications
- University Physics. F.W. Sears, M.W. Zemansky and H.D. Young. 13/e, 1986. Addison-Wesley

Mode of Assessment/ Assessment Tools

(%) Internal:	**40**	
Assignment /Presentation/ attendance/ Class room interaction/quiz etc:		20
Written Test for theory and/or Viva Voce for Laboratory:		20
Final (End Semester):	**60**	
Written Test for theory and/or Laboratory experiments:		60

WAVES AND OPTICS (LAB)
60 Lectures

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 focusing; 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 Grating
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.

Recommended readings:

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

Mode of Assessment/ Assessment Tools (%)

Internal:	**50**
Assignment /Presentation/ attendance/ Class room interaction/quiz etc.:	25
Written Test for theory and/or Viva Voce for Laboratory:	25
Final (End Semester):	**50**
Written Test for theory and/or Laboratory experiments:	50

Expected learner Outcomes: This course will enable the students to

1. Justify different phenomena due to light and the interaction of light among them and with matter.
2. Use different optical instruments.
3. Produce different natural phenomena using different apparatus in the laboratory.