(NEP 2020)

Curriculum and Credit Framework for Under Graduate Programmes

(1st and 2nd Semester)

DEPARTMENT OF PHYSICS

RAJIV GANDHI UNIVERSITY

Doimukh, Arunachal Pradesh

19/06/2023
संयुक्त कुलसचिव (शैक्षणिक एवं सम्मेलन)
राजीव गांधी विश्वविद्यालय
Jt. Registrar (Acad. & Conf.)
Rajiv Gandhi University
Rono Hills, Doimukh (A.P.)

Course Structure of 1st and 2nd semester for Four Years UG Degree with Honours (Physics)

Semester	Course	Credit	Course	Credit	Course	Credit	Course	Credit	Course	Credit	Course	Credit	Total
1st	**Major 1: PHY-CC-1110 Mathematical Physics**	5	Minor 1 (XXX-MN-1110)	4	MDC 1 (XXX-MD-1110)	3	AEC 1 (XXX-AE-1110)	4	SEC 1 (XXX -SE- xxx)	3	VAC 1 (VAC XXX-VA – xxx)	2	**21**
2nd	**Major 2 PHY-CC-1210 Mechanics**	5	Minor 2 (XXX-MN-1220)	4	MDC 2 (XXX-MD-1120)	3	AEC 2 (YYY-AE-1210)	4	SEC 2 (XXX -SE- xxx)	3	VAC 2 (VAC XXX-VA –xxx)	2	**21**

Note:

In the 1st and 2nd semester along with the Major course a Physics (Hons.) student has to choose

a) Two minor courses, one in each semester from CHEMISTRY, MATHEMATICS and STATISTICS as minor
b) Two Multi-disciplinary Course (MDC), one in each semester from any MDC course of discipline available in the college/university in which the student has not studied in 12 standard and not choose a Major or Minor course in the present program.
c) Two Skill Enhancement Course (SEC), one in each semester from any discipline including Physics.
d) One Ability Enhancement Course in the 1st semester as English and one in the second semester from the course offered by other languages.

List of course offered from Physics for students of other discipline:

Minor Courses:

(a) PHY MN 1110: Mechanics
(b) PHY MN 1120: Wave and Optics

Multi-disciplinary Course (MDC):

(a) PHY- MD – 1110: Physics for Everyone
(b) PHY- MD – 1120: Electronics at a Glance
(c) PHY- MD – 1130: Our Universe

Skill Enhancement Course (SEC):

(a) PHY -SE 0010 Basics of Electronic circuits
(b) PHY -SE 0020 Renewable energy and energy harvesting
(c) PHY -SE 0030 Scientific writing through LATEX
(d) PHY -SE 0040 Electronics in everyday life
(e) PHY -SE 0050 Electric and Hybrid Vehicles

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Major Courses

PHY CC 1110: MATHEMATICAL PHYSICS I

PHY CC 1120: MECHANICS

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PHY CC 1110: MATHEMATICAL PHYSICS I

Credit: 5 (L-3: T-0:P-2) **Theory:** 45 Lectures

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

After completing this course, student will be able to,

- Draw and interpret graphs of various elementary functions and their combinations.
- Understand the vector quantities as entities with Cartesian components which satisfy appropriate rules of transformation under rotation of the axes.
- Use index notation to write the product of vectors in compact form.
- Understand the functions of more than one variable and concept of partial derivatives.
- Understand the concept of scalar field, vector field and gradient of scalar fields.
- Understand the properties of discrete and continuous distribution functions.
- Learn the curvilinear coordinates which have applications in problems with spherical and cylindrical symmetries.
- Solve first and second order differential equations and apply these to physics problems.
- Solve the partial differential equation using separation of variable
- In the laboratory, learn the fundamentals of the Python programming languages its use in mathematical and physical problem.

- Functions
- Vector Calculus
- Probability
- Orthogonal Curvilinear Coordinates
- Ordinary differential equations
- Partial differential equations

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

MODULE 1

Functions: Elementary Functions and their representation through table, graph and equation, combination of functions, Symmetry of Functions, different types of elementary functions (linear, quadric, polynomial , algebraic, transcendental functions, trigonometric, exponential, hyperbolic functions, piecewise defined functions), inverse of a function, transformation of functions combinations of elementary functions,

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interpreting graphs of functions using the concepts of calculus, Taylor's series expansion for elementary functions. Multivariable functions **(3 Hours)**

Vector Algebra: Transformation of Cartesian components of vectors under rotation of the axes, Introduction to index notation and summation convention, scalar and vector product and their physical significance, Product of vector of two, three and four vectors and representation in index notation using δ_{ij} and ε_{ijk} , Invariance of scalar product under rotation transformation. Scalar fields and vector fields. **(5 Hours)**

Vector Differentiation: Differentiation of a vector, scalar and vector point functions, Partial derivatives of functions of more than one variable, Product Rule, Quotient Rule, Power Rule, Chain Rule of partial derivatives, vector differential operator $\vec{\nabla}$, Gradient of a scalar field and its geometrical interpretation, normal and directional derivatives, Divergence and curl of a vector field and their physical significance. Del and Laplacian operators, Vector identities. **(7 Lectures)**

MODULE 2

Vector Integration: Ordinary Integrals of Vectors, Multiple integrals: Jacobian. Concept 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). **(6 Lectures)**

Fundamental of Probability: Discrete and continuous random variables, Probability distribution functions, Binomial, Poisson and Gaussian distributions, Mean and variance of these distributions. **(4 Lectures)**

Orthogonal Curvilinear Coordinates: Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems. **(5 Lectures)**

MODULE 3

Ordinary Differential Equations: First order differential equations of degree one and those reducible to this form, Exact and Inexact equations, Integrating Factor, Applications to physics problems. Higher order linear homogeneous differential equations with constant coefficients, Wronskian and linearly independent functions. Non-homogeneous second order linear differential equations with constant coefficients, complementary function, particular integral and general solution, Determination of particular integral using method of undetermined coefficients and method of variation of parameters, Cauchy-Euler equation, Initial value problems. Applications to physics problems **(12 Hours)**

Partial Differential Equations: Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular, cylindrical and spherical symmetry (3 Lectures)

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

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

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PHY CC 1110 (PRACTICUM): PHYSICS LABORATORY I

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

The aim of this Lab is not just to teach computer programming but to emphasize their role programming in solving problems in Physics. This component of the course will also highlight the use of Python Programming to solve various types of mathematical and physical problems.

The major objectives of this Laboratory course are

- Learn the basic of Python programing and its application in problem solving
- Highlights the use of programming to solve physical problems
- The list of programs presented here is only suggestive. Students should be encouraged to do more practice. Emphasis should be given to assess student's ability to formulate a physics.
- Transforming the problem as mathematical one and then solve by computational methods.

After completing this course, student will be able to,

- Learn the basics of Python programming theoretically and practically.
- Get a basic idea about the way of solving problems using Python programming.

- Basic of Python Programming
- Application of Python programming in problem solving

- Computer programming in Python
- Solving of various problems of using Python

Introductions: Algorithms and Flow charts. Branching with examples of conditional statements, for and while loops. Computer programming: types of programming language with example.

Basic Elements of Python: The Python interpreter, the print statement, comments, Python as simple calculator, objects and expressions, variables (numeric, character and sequence types) and assignments, mathematical operators. Strings, Lists, Tuples and Dictionaries, type conversions, input statement, list methods. List mutability Formatting in the print statement.

Control Structures: Conditional operations, if, if-else, if-elif-else, while and for Loops, indentation, break and continue, List comprehension.

Functions: Inbuilt functions, user-defined functions, local and global variables, passing functions, modules, importing modules, math module, making new modules.

Suggestive list for exercise:

(a) Basics Programs:

1. *Python program to add two numbers*
2. *Maximum of two numbers in Python*
3. *Python Program for factorial of a number*
4. *Python Program for simple interest*
5. *Python Program for compound interest*

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6. *Python Program to check Armstrong Number*
7. *Python Program for Program to find area of a circle*
8. *Python program to print all Prime numbers in an Interval*
9. *Python program to check whether a number is Prime or not*
10. *Python Program for n-th Fibonacci number*
11. *Python Program for How to check if a given number is Fibonacci number?*
12. *Python Program for n\'th multiple of a number in Fibonacci Series*
13. *Program to print ASCII Value of a character*
14. *Python Program for Sum of squares of first n natural numbers*
15. *Python Program for cube sum of first n natural numbers*

(b) Programs with Array

1. *Python Program to find sum of array*
2. *Python Program to find largest element in an array*
3. *Python Program for array rotation*
4. *Python Program for Reversal algorithm for array rotation*
5. *Python Program to Split the array and add the first part to the end*
6. *Python Program for Find reminder of array multiplication divided by n*
7. *Python Program to check if given array is Monotonic*

(c) Programs with List

1. *Python program to interchange first and last elements in a list*
2. *Python program to swap two elements in a list*
3. *Python | Ways to find length of list*
4. *Python | Ways to check if element exists in list*
5. *Different ways to clear a list in Python*
6. *Python | Reversing a List*
7. *Python program to find sum of elements in list*
8. *Python | Multiply all numbers in the list*
9. *Python program to find smallest number in a list*
10. *Python program to find largest number in a list*
11. *Python program to find second largest number in a list*
12. *Python program to find N largest elements from a list*
13. *Python program to print even numbers in a list*
14. *Python program to print odd numbers in a List*
15. *Python program to print all even numbers in a range*
16. *Python program to print all odd numbers in a range*
17. *Python program to print positive numbers in a list*
18. *Python program to print negative numbers in a list*
19. *Python program to print all positive numbers in a range*
20. *Python program to print all negative numbers in a range*
21. *Remove multiple elements from a list in Python*
22. *Python – Remove empty List from List*
23. *Python | Cloning or Copying a list*
24. *Python | Count occurrences of an element in a list*
25. *Python | Remove empty tuples from a list*
26. *Python | Program to print duplicates from a list of integers*
27. *Python program to find Cumulative sum of a list*
28. *Python | Sum of number digits in List*
29. *Break a list into chunks of size N in Python*
30. *Python | Sort the values of first list using second list*

(d) Programs with Matrix

1. *Python program to add two Matrices*

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2. *Python program to multiply two matrices*
3. *Python program for Matrix Product*
4. *Adding and Subtracting Matrices in Python*
5. *Transpose a matrix in Single line in Python*
6. *Python | Matrix creation of n*n*
7. *Python | Get Kth Column of Matrix*
8. *Python – Vertical Concatenation in Matrix*

(e) Programs with String

1. *Python program to check if a string is palindrome or not*
2. *Python program to check whether the string is Symmetrical or Palindrome*
3. *Reverse words in a given String in Python*
4. *Ways to remove i'th character from string in Python*
5. *Python | Check if a Substring is Present in a Given String*
6. *Python – Words Frequency in String Shorthands*
7. *Python – Convert Snake case to Pascal case*
8. *Find length of a string in python (4 ways)*
9. *Python program to print even length words in a string*
10. *Python program to accept the strings which contains all vowels*
11. *Python | Count the Number of matching characters in a pair of string*
12. *Remove all duplicates from a given string in Python*
13. *Python – Least Frequent Character in String*
14. *Python | Maximum frequency character in String*
15. *Python | Program to check if a string contains any special character*
16. *Generating random strings until a given string is generated*
17. *Find words which are greater than given length k*
18. *Python program for removing i-th character from a string*
19. *Python program to split and join a string*
20. *Python | Check if a given string is binary string or not*
21. *Python program to find uncommon words from two Strings*
22. *Python – Replace duplicate Occurrence in String*
23. *Python – Replace multiple words with K*
24. *Python | Permutation of a given string using inbuilt function*
25. *Python | Check for URL in a String*
26. *Execute a String of Code in Python*
27. *String slicing in Python to rotate a string*
28. *String slicing in Python to check if a string can become empty by recursive deletion*
29. *Python Counter| Find all duplicate characters in string*
30. *Python – Replace all occurrences of a substring in a string*

(f) Programs with Dictionary

1. *Python – Extract Unique values dictionary values*
2. *Python program to find the sum of all items in a dictionary*
3. *Python | Ways to remove a key from dictionary*
4. *Ways to sort list of dictionaries by values in Python – Using itemgetter*
5. *Ways to sort list of dictionaries by values in Python – Using lambda function*
6. *Python | Merging two Dictionaries*
7. *Python – Convert key-values list to flat dictionary*
8. *Python – Insertion at the beginning in OrderedDict*
9. *Python | Check order of character in string using OrderedDict( )*
10. *Dictionary and counter in Python to find winner of election*
11. *Python – Append Dictionary Keys and Values (In order) in dictionary*
12. *Python | Sort Python Dictionaries by Key or Value*

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13. *Python – Sort Dictionary key and values List*
14. *Handling missing keys in Python dictionaries*
15. *Python dictionary with keys having multiple inputs*
16. *Print anagrams together in Python using List and Dictionary*
17. *K'th Non-repeating Character in Python using List Comprehension and OrderedDict*
18. *Check if binary representations of two numbers are anagram*
19. *Python Counter to find the size of largest subset of anagram words*
20. *Python | Remove all duplicates words from a given sentence*
21. *Python Dictionary to find mirror characters in a string*
22. *Counting the frequencies in a list using dictionary in Python*
23. *Python | Convert a list of Tuples into Dictionary*
24. *Python counter and dictionary intersection example (Make a string using deletion and rearrangement)*
25. *Python dictionary, set and counter to check if frequencies can become same*
26. *Scraping And Finding Ordered Words In A Dictionary using Python*
27. *Possible Words using given characters in Python*
28. *Python – Keys associated with Values in Dictionary*

(g) Programs with Tuple

1. *Python program to Find the size of a Tuple*
2. *Python – Maximum and Minimum K elements in Tuple*
3. *Create a list of tuples from given list having number and its cube in each tuple*
4. *Python – Adding Tuple to List and vice – versa*
5. *Python – Closest Pair to Kth index element in Tuple*
6. *Python – Join Tuples if similar initial element*
7. *Python – Extract digits from Tuple list*
8. *Python – All pair combinations of 2 tuples*
9. *Python – Remove Tuples of Length K*
10. *Sort a list of tuples by second Item*
11. *Python program to Order Tuples using external List*
12. *Python – Flatten tuple of List to tuple*
13. *Python – Convert Nested Tuple to Custom Key Dictionary*

(h) Programs for Searching and Shorting

1. *Python Program for Binary Search (Recursive and Iterative)*
2. *Python Program for Linear Search*
3. *Python Program for Insertion Sort*
4. *Python Program for Recursive Insertion Sort*
5. *Python Program for QuickSort*
6. *Python Program for Iterative Quick Sort*
7. *Python Program for Selection Sort*
8. *Python Program for Bubble Sort*
9. *Python Program for Merge Sort*
10. *Python Program for Iterative Merge Sort*
11. *Python Program for Heap Sort*
12. *Python Program for Counting Sort*
13. *Python Program for ShellSort*
14. *Python Program for Topological Sorting*
15. *Python Program for Radix Sort*
16. *Python Program for Binary Insertion Sort*
17. *Python Program for Bitonic Sort*
18. *Python Program for Comb Sort*
19. *Python Program for Pigeonhole Sort*

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20. *Python Program for Cocktail Sort*
21. *Python Program for Gnome Sort*
22. *Python Program for Odd-Even Sort / Brick Sort*
23. *Python Program for BogoSort or Permutation Sort*
24. *Python Program for Cycle Sort*
25. *Python Program for Stooge Sort*

(i) Program with Date and time

1. *Python program to get Current Time*
2. *Get Current Date and Time using Python*
3. *Python | Find yesterday's, today's and tomorrow's date*
4. *Python program to convert time from 12 hour to 24 hour format*
5. *Python program to find difference between current time and given time*
6. *Python Program to Create a Lap Timer*
7. *Convert date string to timestamp in Python*
8. *How to convert timestamp string to datetime object in Python?*

(j) Programs with 'functions'

1. *Define a function that accepts 2 values and return its sum, subtraction and multiplication.*
2. *Define a function that accepts roll number and returns whether the student is present or absent.*
3. *Define a function in python that accepts 3 values and returns the maximum of three numbers.*
4. *Define a function that accepts a number and returns whether the number is even or odd.*
5. *Define a function which counts vowels and consonant in a word.*
6. *Define a function that returns Factorial of a number.*
7. *Define a function that accepts lowercase words and returns uppercase words.*
8. *Define a function that accepts radius and returns the area of a circle*.

Recommended List of Programs

(a) Make a python function that takes a number N as input and returns the value of factorial of N and compare with the output of math.factorial() method. Use this function to print the number of ways a set of m red and n blue balls can be arranged.

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

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

1. Core Python Programming 3ed, R. Nageswara Rao, Dreamtech Press
2. Python Crash Course: A Hands-On, Project-Based Introduction to Programming, Eric Matthes
3. Learn More Python 3 the Hard Way: The Next Step for New Python Programmers, Zed A. Shaw

1. Head-First Python: A Brain-Friendly Guide (2nd Edition), Paul Barry
2. Documentation at the Python home page (https://docs.python.org/3/) and the tutorials there (https://docs.python.org/3/tutorial/)
3. Python Cookbook: Recipes for Mastering Python 3, by David Beazley, Brian K. Jones

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PHY CC 1120: MECHANICS

Credit: 5 (L-3: T-0:P-2) **Theory:** 45 Lectures

This course reviews the concepts of mechanics learnt at school from a more advanced perspective and goes on to build new concepts. It begins with dynamics of particles and ends with the properties of matter. The students will learn the collisions in the centre of mass frame, rotational motion and central forces. They will be able to apply the concepts learnt to several real-world problems.

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

- Understand laws of motion and their applications. He / she will learn the concept of conservation of energy, momentum, angular momentum to apply them to basic problems.
- Describe how fictitious forces arise in a non-inertial frame, e.g., why a person sitting in a merry-go-round experiences an outward pull.
- Understand the phenomena of collisions and idea about center of mass and laboratory frames and their correlation.
- Understand the analogy between translational and rotational dynamics, and application of both motions simultaneously in analysing rolling with slipping.
- Write the expression for the moment of inertia about the given axis of symmetry for different uniform mass distributions.
- Apply Kepler's law to describe the motion of planets and satellite in circular orbit, through the study of law of Gravitation.
- Three basic properties of matter – elasticity, viscosity and surface tension and determination of various parameter related to these material

- Fundamental of Dynamics
- Work and Energy
- Collisions
- Rotational Dynamics
- Elasticity
- Viscosity
- Surface Tension

- Learn basics of the kinematics and dynamics linear and rotational motion.
- Develop skills to understand and solve the equations of central force problem.
- Learn the concepts of elastic in constant of solids and viscosity of fluids.

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MODULE 1

Fundamentals of Dynamics: Inertial and Non-inertial frames- fictitious forces, Newton's Laws of Motion and their invariance under Galilean transformations. Momentum of variable mass system: motion of rocket, Motion of a projectile in Uniform gravitational field. Dynamics of a system of particles: principle of conservation of momentum. Impulse. Determination of centre of mass of discrete and continuous objects having cylindrical and spherical symmetry, Differential Analysis of a static vertically hanging massive rope **(7 Lectures)**

Work and Energy: Work and Kinetic Energy Theorem. Conservative forces and examples (Gravitational and electrostatic), non-conservative forces and examples (velocity dependent forces e.g., frictional force, magnetic force). Potential Energy. Energy diagram. Stable, unstable and neutral equilibrium. Elastic potential energy, Force as gradient of the potential energy. Work & Potential energy, Work done by non-conservative forces. Law of conservation of Energy **(5 Lectures)**

Collisions: Elastic and inelastic collisions, Kinematics of 2 → 2 scattering in centre of mass and laboratory frames. **(3 Lectures)**

MODULE 2

Rotational Dynamics: Angular momentum of a particle and system of particles. Torque. Principle of conservation of angular momentum. Rotation about a fixed axis. Determination of moment of inertia of symmetric rigid bodies (rectangular, cylindrical and spherical). Application of parallel and perpendicular axes theorems. Kinetic energy of rotation. Motion involving both translation and rotation, Rotating frame of references, Centrifugal force, Coriolis force and its applications. **(8 Hours)**

Central Force Motion: Central forces, Law of conservation of angular momentum for central forces, Two-body problem and its reduction to equivalent one-body problem and its solution. Concept of effective potential energy and stability of orbits for central potentials of the form kT^n for $n = 2$ and -1 using energy diagram, discussion on trajectories for $n = -2$. Solution of Kepler's problem, Kepler's laws for planetary motion, orbit for artificial satellites. **(7 Lectures)**

MODULE 3

Elasticity: Relation between the three elastic constants, Poison's ratio, Twisting torque on a Wire, Determination of Rigidity modulus by static torsion, Torsional pendulum, Determination of Rigidity modulus and moment of inertia - q, η and γ by Searles method. Bending of beam, bending moment, cantilever, depression of a beam supported at the ends and loaded at the centre, determination of Young's modulus by banding of beam.

(7 Lectures)

Viscosity: Streamline flow, Turbulent flow , critical velocity, Reynolds Number and its significate, Bernoulli's Theorem, Poiseuille's equation, determination of coefficient of viscosity by Poiseuille's method. - Variations of viscosity of liquid with temperature- lubrication **(4 Lectures)**

Surface Tension: Pressure difference across a curved surface, expression for excess pressure inside a spherical drop and spherical shop bubble, surface tension by Jaeger's method and Ferguson method. **(4 Lectures)**

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

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

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Jt. Registrar (Acad. & Conf.)
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Rono Hills, Doimukh (A.P.)

PHY CC 1120 (PRACTICUM) : PHYSICS LABORATORY II

Credit: Practical: 02 (30 hours)

Practicum: 60 Hours

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

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

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

1. Measurements of length (or diameter) using Vernier caliper, screw gauge and travelling microscope.
2. To study the random error in observations.
3. To determine the height of a building using a Sextant.
4. To study the Motion of Spring and calculate (a) Spring constant, (b) gravitational constant and (c) Modulus of rigidity.
5. To determine the Moment of Inertia of a Flywheel.
6. To determine g and velocity for a freely falling body using Digital Timing Technique.
7. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
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.

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

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

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Minor Courses

PHY MC 1110: MECHANICS

PHY MC 1210: WAVE AND OPTICS

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PHY MC 1110: MECHANICS

Credit: Theory: 03 (45 Lectures), Practical : 01 (30 Hours)

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

This course reviews the concepts of mechanics learnt at school in a more advanced perspective and goes on to build new concepts. It begins with dynamics of a system of particles and ends with the special theory of relativity. Students will appreciate the concept of rotational motion, gravitation and oscillations. The students will be able to apply the concepts learnt to several real-world problems. A brief recapitulation of vector algebra and differential equations is also done to familiarize students with basic mathematical concepts which are necessary for a course on mechanics

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

- Understand the role of vectors and coordinate systems in Physics.
- Laws of motion and their application to various dynamical situations. And their applications to conservation of momentum, angular momentum and energy.
- Rotational motion and moment of inertia with different types of mass distribution
- Understand the analogy between translational and rotational dynamics, and application of both motions simultaneously in analyzing rolling with slipping.
- Apply Kepler's law to describe the motion of planets and satellite in circular orbit.
- The concept of geosynchronous orbits and its applications
- the properties of systems executing simple harmonic motion
- Motion of simple and compound pendulum
- Describe how fictitious forces arise in a non-inertial frame, e.g., why a person sitting in a merry-go-round experiences an outward pull.
- Describe special relativistic effects and their effects on the mass and energy of a moving object.
- Postulates of Special Theory of Relativity, Lorentz transformation, relativistic effects on the mass and energy of a moving body.
- In the laboratory course, after acquiring knowledge of how to handle measuring instruments (like screw gauge, Vernier callipers, Travelling microscope) student shall embark on verifying various principles learnt in theory. Measuring 'g' using Bar Pendulum, Kater pendulum and measuring elastic constants of materials, viscous properties of liquids etc.

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

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- Viscosity
- Surface Tension
- Special Theory of Relativity

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

MODULE 1:

Vectors: Vector algebra. Scalar and vector products, gradient of a scalar field, divergence and curt of a vector field. **(3 Lectures)**

Ordinary Differential Equations: First order homogeneous differential equations. 2nd order homogeneous differential equations with constant coefficients. **(5 Lectures)**

Fundamentals of Dynamics: Dynamics of a system of particles, centre of mass, determination of centre of mass for discrete and continuous systems having spherical symmetry, Conservation of momentum and energy, Conservative and non-Conservative forces, work – energy theorem for conservative forces, force as a gradient of potential energy, Motion of rockets. **(7 Lectures)**

MODULE 2

Rotational Dynamics: Angular velocity, angular momentum, torque, conservation of angular momentum, Moment of inertia, Theorem of parallel and perpendicular axes, Calculation of moment of inertia of discrete and continuous objects (1-D and 2-D). **(5 Lectures)**

Gravitation: Newton's Law of Gravitation. Motion of a particle in a central force field, two body problem Kepler's Laws (statement only). Satellite in circular orbit and applications. Geosynchronous orbits. **(5 Lectures)**

Oscillation and waves: Idea of simple harmonic motion, Differential equation of simple harmonic motion and its solution, Motion of a simple pendulum and compound pendulum **(5 Lectures)**

MODULE 3

Elasticity: Concept of stress and strain, Hooke's law, elastic moduli, twisting torque on a wire, tensile strength, relation between elastic constants, Poisson's ratio, rigidity modulus **(3 Lectures)**

Viscosity: Rate flow of liquid in a capillary tube - Poiseuille's formula - Determination of coefficient of viscosity of a liquid, Variations of viscosity of liquid with temperature- lubrication. **(3 Lectures)**

Surface Tension: Synclastic and anticlastic surface - Excess of pressure -Application to spherical and cylindrical drops and bubbles - variation of surface tension with temperature - Jaegar's method. **(3 Lectures)**

Special Theory of Relativity: Postulates of Special Theory of Relativity, Lorentz transformation, length contraction, time dilation, relativistic transformation of velocity, relativistic variation of mass, mass-energy equivalence **(6 Lectures)**

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

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

- **Internal assessment:** 20 marks
- **End term examination:** 80 marks
- **Pattern of End term question paper**

Section	Total Questions	Max. Marks for each question	have to attempt	Total Marks	Distribution of questions
A	6	5	4	20	Minimum one question from each Module
B	6	15	4	60	Minimum one question from each Module

* ***Each question can be split into small questions***

PHY MC 1110: MINOR PHYSICS LABORATORY I

Credit: Practical: 01 (30 hours) **Practicum:** 30 Hours

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

Though the laboratory works a student will learn

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

- To use of various measuring instruments used in any science laboratory.
- Skill to use of graph between two different physical quantities to calculate an unknown quantity.
- Art of scientific report wringing of laboratory work.
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1. Measurements of length (or diameter) using vernier caliper, screw gauge and travelling microscope.
2. To determine the Height of a Building using a Sextant.
3. To determine the Moment of Inertia of a Flywheel.
4. To determine the Young's Modulus of a Wire by Optical Lever Method.
5. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
6. To determine the Elastic Constants of a Wire by Searle's method.
7. To determine g by Bar Pendulum.
8. To determine g by Kater's Pendulum.
9. To study the Motion of a Spring and calculate (a) Spring Constant, (b) g.

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

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

Total Marks: 50

- **Internal assessment:** 10 marks(based on performance like sincerity, regularity, etc.)
- **End term examination:** 40 (laboratory examination will be conducted at the semester end)

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PHY MC 1210: WAVE AND OPTICS

Credit: Theory: 03 (45 Lectures), Practical : 01 (30 Hours)

This course reviews the concepts of waves and optics learnt at school from a more advanced perspective and goes on to build new concepts. It begins with explaining ideas of superposition of harmonic oscillations leading to physics of travelling and standing waves.

The course also provides an in depth understanding of wave phenomena of light, namely, interference and diffraction with emphasis on practical applications of the same

This course will enable the student to

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

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

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- This course in basics of optics will enable the student to understand various optical phenomena, principles, workings and applications optical instruments
- He / she shall develop an understanding of Waves Motion and its properties.

MODULE 1:

Superposition of Harmonic Oscillations: Simple harmonic motion (SHM). Linearity and Superposition Principle. Superposition of two collinear harmonic oscillations having (1) equal frequencies and (2) different frequencies (Beats). Superposition of two perpendicular harmonic oscillations: Graphical and Analytical Methods. Lissajous Figures (1:1 and 1:2) and their uses **(10 Lectures).**

Waves Motion: Types of waves: Longitudinal and Transverse (General idea). Travelling waves in a string, wave equation. Energy density. Standing waves in a string - modes of vibration. Group velocity, Phase velocity, plane waves, spherical waves, wave intensity **(5 Lectures).**

MODULE 2

Sound: damped vibration and 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 **(5 Lectures)**

Interference of Light: Electromagnetic nature of light, Huygens Principle. Interference: Division of amplitude and division of wave front. Young's Double Slit experiment. Lloyd's Mirror and Fresnel's Biprism, Phase change on reflection: Stoke's 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 **(10 Lectures).**

MODULE 3

Michelson's Interferometer: Idea of form of fringes (no theory needed), Determination of wavelength, Wavelength difference, Refractive index, and Visibility of fringes. **(3 Lectures)**

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. **(10 Lectures)**

Polarization: Transverse nature of light waves. Plane polarized light – production and analysis. Circular and elliptical polarization. **(2 Lectures)**

1. Physics of Oscillations and Waves, N. K. Bajaj, McGraw-Hill Education
2. Principles of Optics, B.K. Mathur, 1995, Gopal Printing
3. Fundamentals of Optics, H.R. Gulati and D.R. Khanna, 1991, R. Chand Publications

1. Fundamentals of Optics, F.A Jenkins and H.E White, 1976, McGraw-Hill
2. University Physics. F.W. Sears, M.W. Zemansky and H.D. Young. 13/e, 1986. Addison- Wesley

PHY GE 1210: MINOR PHYSICS LABORATORY II

Practicum: 30 Hours

COURSE OBJETIVES

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

COURSE LEARNING OUTCOME

From various experiments in the course student will learn

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

SKILLS TO BE LEARNED

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

DETAILED CONTENTS OF THE COURSE

1. To investigate the motion of coupled oscillators
2. To determine the Frequency of an Electrically Maintained Tuning Fork by Melde's Experiment and to verify λ^2 – T Law.
3. To study Lissajous Figures
4. Familiarization with Schuster`s focussing; determination of angle of prism.
5. To determine the Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
6. To determine the Refractive Index of the Material of a Prism using Sodium Light.
7. To determine Dispersive Power of the Material of a Prism using Mercury Light
8. To determine the value of Cauchy Constants.
9. To determine the Resolving Power of a Prism.
10. To determine wavelength of sodium light using Fresnel Biprism.
11. To determine wavelength of sodium light using Newton's Rings.
12. To determine the wavelength of Laser light using Diffraction of Single Slit.
13. To determine wavelength of (1) Sodium and (2) Spectral lines of the Mercury light using plane diffraction Gratin
14. To determine the Resolving Power of a Plane Diffraction Grating.
15. To measure the intensity using photosensor and laser in diffraction patterns of single and double slits.

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

REFERENCE BOOKS

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers

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Multi-disciplinary Course

PHY MD 1110: PHYSICS FOR EVERYONE

PHY MD 1210: ELECTRNOICS AT A GLANCE

PHY MD 1310: KNOWING OUR UNIVERSE

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PHY MD 1110: PHYSICS FOR EVERYONE

Credit 2: Theory 3 (45 Lectures)

The aim of the course is to provide fundamental knowledge of diverse phenomena of physics and their practical applications to the students coming from non-scientific background. Enrichment of scientific knowledge related to various physical phenomena is an additional objective of the present course.

- Upon completion of the course, students will be aware of the historical development of science and will fetch idea about the methods of scientific approach for explaining physical phenomena.
- The students will acquire fundamental knowledge about different types of laws governing the motion of bodies observed in daily life.
- Students will come across the basic concept on gravitation and its applications.
- Students can develop idea about the physical mechanism behind the physical events like heat, magnetism and wave propagation etc.

- Physics and its Historical development
- Measurement system
- Observation and experimentation in Physics
- Motion of object and rotational motion
- Gravitation
- Thermal physics
- Wave and sounds
- Electromagnetic waves.

- Skills to measure to different physical parameter related to any object.
- Skills to understand about steps to study of physics
- Skills to understand different natural phenomena and its cause

Physics and its Historical development: What is physics and its importance in our life, The historical, philosophical, and practical evolution of Physics from its roots in ancient natural philosophy. Preliterate origins, Ancient Egypt and Mesopotamia, modern science after 15th centuries. A golden age of physics

Measurement system: Measurement and its importance in physics, History of unit and measurement systems, international system of units, significant figures and rounding off in measurement, rules for arithmetic operation with significant digits.

Observation and experimentation in Physics: Steps of scientific study of natural behaviour of objects, observation, design of experiment, experimental data collection, analysis of experimental data: drawing curve, formation of equation, development of phenomena, Importance of curve and equation in physics.

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Motion of object: Scaler and vector quantities with examples, displacement, speed and velocity, acceleration, momentum, Newton's laws of motion and its applications.

Work, Energy and Power: Work done, Kinetic energy and potential energy, power

Rotational Motion: Rigid body under rotation, rotational axis, centre of mass, angular velocity, angular acceleration, Torque, center of gravity, idea about moment of inertia and tis applications.

Gravitation: Kepler's laws, Universal Law of Gravitation: Gravitational constant, acceleration due to gravity, variation of acceleration due to gravity in earth (above and below earth surface), Escape speed, Artificial Satellites- geosynchronous satellites.

Thermal Physics: Heat and temperature – measurement techniques, heat transfer: conduction, convection and radiation, Newton's laws of cooling, fundamental idea about heat engine.

Waves and sound: Periodic and oscillatory motions, concept of frequency and wavelength, waves: Transverse and longitudinal, speed of waves, sound

Magnetism: Properties of magnets, lines of forces and flux, magnetic needle, earth's magnetic field, artificial magnet, electromagnetic induction: Lenz's law, AC generator

Electromagnetic waves: Nature of electromagnetic waves, electromagnetic spectrum, radio waves, microwave, infra-red waves, visible rays, UV-rays, X-rays and gamma rays and their applications.

[redacted]

1. Physics (Part 1) Text Book for class 11 (NCERT)
2. Physics (Part 2) Text Book for class 11 (NCERT)
3. Physics (Part 1) Text Book for class 12 (NCERT)
4. Physics (Part 2) Text Book for class 12 (NCERT)

[redacted]

1. Basic Physics: A Self-Teaching Guide by Karl F. Kuhn and Frank Noschese
2. PHYSICS My love: Story of Physics for Everyone by Shuvadip Ganguli

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PHY MD 1210: ELECTRNOICS AT A GLANCE

Credit : 3 (45 Lectures)

The present course aims to deliver essential knowledge about electricity and electronic components encountered in our day-to-day life to the students coming from non-scientific background. It will edify the working principle and phenomena behind the electrical components.

- Upon completion of this course the student will acquire fundamental knowledge of electricity and its generation techniques.
- The student will acquire knowledge about various applications of electrical components and the ongoing physics of the component.
- The student will achieve preliminary idea about the electronic communication systems used in our daily life.

- Basic principles of electric current
- Generation and storage of electric current
- Electronic components and their use
- Electronic communication.

- Skills to distinguish the types of electrical current and its use
- Skills to understand the various types of battery and electricity generation mechanism.
- Develop knowledge of different types of electrical components and their use.
- Get an idea about the present communication systems.

Fundamental of electricity: electric charge, conductor and insulator, static electricity: generation of static electricity, Electroscopes, current electricity: concept of resistance, ohm's law, direct current and alternating current, pulse, wave, signal and noise, Voltage, Current, Resistance, and Power

Electrical sources: DC sources: Electrical cell (Battery), emf, Internal Resistance, different types of battery and their applications, rechargeable battery, AC sources: electric generator, turbine, hydropower, thermal energy sources, nuclear energy

Electronic components: Wire and cables, switches, moving coil meters, microphone and speakers, resistor, capacitors and inductors (coils)

Semiconductor devices: Diode, transistor, FET, MOSFET, Thyristor, SCR, Triacs, optoelectronic components: Light emitting diode, photodiode, phototransistor, photo-thyristors, solar cells. Integrated circuits. Application of diode, transistor, SCR etc.

Electronic communications: Block diagram of electronic communication, AM and FM,

1. Getting Started in Electronics, Forrest M. Mims

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1. A text book of Electrical Technology - A K Theraja

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PHY MD 1310: KNOWING OUR UNIVERSE

Credit 2: Theory 3 (45 Lectures)

The aim of this course is to enable the students from social science and humanities to give the basic idea about our universe. Edify about the various phenomena observed in night sky is also an objective of this Couse. It also aims

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

students will learn the

- fundamentals of the science of Astronomy, including its history.
- Basics of various tools of Astronomy with emphasis on different types of telescopes.
- receive an introduction to the solar system and the characteristics of each of the planets
- Basics of formation stars and identification
- learn about space, the interstellar medium, and its properties as well as the unsolved mysteries of dark energy and dark matter.
- The course also discusses milestones in space exploration, as well as contemporary issues and players in the space travel industry.

- Historical development of astronomy
- Solar System
- Stars and galaxy
- Space Exploration and Search for Life

- Skills to observed the night sky
- Skills to understand the working of various types of telescopes
- Sills to distinguish different astronomical object: star, galaxy, milky-way etc.
- Skill to understand various astronomical evets in night sky

The Science of Astronomy: What is Astronomy, Naked Eye Observations, A Brief History of Space Science**,** Pioneers of cosmic observers: Nicolaus Copernicus, Johannes Kepler, Galileo Galilei, Edwin Hubble etc. **(6 lecture)**

Tools of Astronomy: History of Telescope, Reflecting Telescopes, Refracting Telescopes, types of reflecting telescope - advantages of reflecting telescope, Radio and Other Telescopes, Space-Based Telescopes. **(6 lecture)**

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Solar system: The sun-physical and orbital data - Photosphere - Chromosphere - corona - solar prominences - sunspot - sunspot cycle - theory of sunspots - solar flare -mass of the sun - solar constant - temperature of the sun - source of solar energy - solar wind. Other members of the solar system – planets and satellites Bode's law - Asteroids - comets - Meteors. The Pluto Dilemma, The Asteroid Belt, Comets and the Oort Cloud, Size Comparisons of Celestial Bodies, **(10 lecture)**

Stars and Galaxies: Stellar Evolution, elementary idea about birth and death of star, Chandrasekar limit, Supernovae, White Dwarfs and Planetary Nebulae, Brown Dwarfs, Neutron Stars, Black Holes, Pulsars and Quasar, Theories of the universe, galaxies and star clusters Origin of the universe - the big bang theory Hubble's law. Galaxies - types of galaxies - Milky Way - star clusters - open clusters - globular Clusters, Hubble deep field and ultra-deep field, Galactic collisions. **(10 lecturer)**

Space Exploration and Search for Life: A Brief History of Space Exploration, The First Man in Space, The Apollo Missions, Voyager, The International Space Station, Private Companies and NGOs, The Future of Human Space Exploration, The Challenges of Interstellar Travel. India on space, space mission of India: first satellite, space mission to moon, space mission to mars. The Search for Life in the Solar System: Europa and Enceladus, Exoplanets and Astrobiology. **(8 lecturer)**

[redacted]

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

[redacted]

1. Cosmos –Carl Sagan
2. A Brief History of Time – Stephen Hawking

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Skill Enhancement Course

PHY SE 0010: BASICS OF ELECTRONIC CIRCUITS

PHY SE 0020: RENEWABLE ENERGY AND ENERGY HARVESTING

PHY SE 0030: COMPUTER SKILL FOR SCIENTIFIC WRITING

PHY SE 0040: ELECTRONICS IN EVERYDAY LIFE

PHY SE 0050: ELECTRIC AND HYBRID VEHICLES

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PHY SE 0010: BASICS OF ELECTRONIC CIRCUITS

Credit 3: Theory 2 (30 Lectures), Practical 1 (30 hours)

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

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

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

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

Basic Electricity Principles: Voltage, Current, Resistance, and Power. Ohm's law. Series, parallel, and series-parallel combinations. AC Electricity and DC Electricity. Familiarization with mustimeter, voltmeter and ammeter. **(8 Lectures)**

Understanding Electrical Circuits: Main electric circuit elements and their combination. Rules to analyse DC sourced electrical circuits. Current and voltage drop across the DC circuit elements. Single-phase and three-phase alternating current sources. Rules to analyse AC sourced electrical circuits. Real, imaginary and complex power components of AC source. Power factor. Saving energy and money. **(8 Lectures)**

Electrical Drawing and Symbols: Drawing symbols. Blueprints. Reading Schematics. Ladder diagrams. Electrical Schematics. Power circuits. Control circuits. Reading of circuit schematics. Tracking the connections of elements and identify current flow and voltage drop. **(8 Lectures)**

Solid-State Devices: Resistors, inductors and capacitors. Diode and rectifiers. Components in Series or in shunt. Response of inductors and capacitors with DC or AC sources **(6 Lectures)**

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[redacted]

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

[redacted]

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

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PHY SE 0010(PRACTIRUM):: ELECTRONIC CIRCUIT LABOATORY

Credit : 1 (30 hr)

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

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

Part 1: Laboratory skill:

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

Part 2: Experiment:

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

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

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

PHY SE 0020: RENEWABLE ENERGY AND ENERGY HARVESTING

Credit 2: Theory 2 (30 Lectures), Practical 1 (30 hours)

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

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

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

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

Fossil fuels and Alternate Sources of energy: Fossil fuels and nuclear energy, their limitation, need of renewable energy, non-conventional energy sources. An overview of developments non-conventional energy. **(8 Lectures)**

Solar energy: Solar energy, its importance, storage of solar energy, solar pond, non-convective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning. **(8 Lectures)**

Wind Energy harvesting: Fundamentals of Wind energy, Wind Turbines- its construction. Power electronic interfaces, and grid interconnection topologies. **(4 Lectures)**

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Hydro Energy: Hydropower resources, hydropower technologies, environmental impact of hydro power sources. **(4 Lectures)**

Ocean Energy: Ocean Energy Potential against Wind and Solar, Wave Energy Devices. Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass. **(4 Lectures)**

Geothermal Energy: Geothermal Resources and Technologies. **(2 Lectures)**

1. Non-conventional energy sources - G.D Rai - Khanna Publishers, New Delhi
2. Solar energy - M P Agarwal - S Chand and Co. Ltd.
3. Solar energy - Suhas P Sukhative Tata McGraw - Hill Publishing Company Ltd.

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

PHY SE 0020(PRACTIRUM): PROJECT ON RENEWABLE ENERGY

Credit: 1 (30 hours)

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

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

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PHY SE 0030: SCIENTIFIC WRITING THROUGH LATEX

Credit 2: Theory 2 (30 Lectures), Practical 1 (30 hours)

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

Student will able to

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

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

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

Introduction: History of LaTeX and its installation, different IDEs. How to create a document in LaTex, understanding Latex compilation. How to organize content into sections using article and book class of Latex. **(6 Lecturer)**

Styling Pages: Review of different paper sizes, examines packages, formats the page by setting margins, customizing header and footer, changing the page orientation, dividing the document into multiple columns. The topic ends with reading different types of error messages. **(6 Lecturer)**

Formatting Content: Formatting text (styles, size, alignment), adding colors to text and entire page, and adding bullets and numbered items. It concludes by explaining the process of writing complex mathematics. **(6 Lecturer)**

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PHY SE 0030: COMPUTER SKILL FOR SCIENTIFIC WRITING

Credit 2: Theory 2 (30 Lectures), Practical 1 (30 hours)

The objective of this course is to impart knowledge to students on how to write scientific writing, to display complex graphics, and present scientific report presentations with LATEX software, which are the de-facto standard in Physics as well as other areas.

After the completion of this course, student will be able to

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

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

- Skill to prepare official document to dissertation using Latex
- Skill to prepare presentations
- Skill to plot and include graphs, tables

Introduction: History of LaTeX and its installation, different IDEs, How to create a document in LaTex, understanding Latex compilation, organisation of content into sections using article and book class of Latex. **(6 Lecturer)**

Styling Pages: Review of different paper sizes, examines packages, formats the page by setting margins, customizing header and footer, changing the page orientation, dividing the document into multiple columns. The topic ends with reading different types of error messages. **(6 Lecturer)**

Formatting Content: Formatting text (styles, size, alignment), adding colors to text and entire page, and adding bullets and numbered items. It concludes by explaining the process of writing complex mathematics. **(6 Lecturer)**

Tables and Images: Creating basic tables, plotting and inserting figures and graphics using suitable packages, adding simple and dashed borders, merging rows and columns, and handling situations where a table exceeds the size of a page, explore different properties of images (tables) like rotation, scale, etc. **(6 lecturer)**

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Referencing and Indexing: Adding cross-referencing (refer to sections, table, images), add bibliography (references), and create back index. **(3 Lecturer)**

Presentation using Beamer: Introduction to creating slides, adding frames, dividing the slide into multiple columns, adding different blocks, etc. **(3 Lecturer)**

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

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

PHY SE 0030 (PRACTICAL) : PROJECT ON SCIENTIFIC WRITING

Credit 1: (30 hours)

To learn the practical use of Latex software.

Students have to use Latex to

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

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PHY SE 0040: ELECTRONICS IN EVERYDAY LIFE

Credit 2: Theory 2 (30 Lectures), Practical 1 (30 hours)

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

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

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

Basics of electricity: Electrical charge, Current and voltage, resistance, inductance, capacitance. DC Power supply- batteries. AC currents – single phase and three phase, RMS and peak value. Power stations. Basics of Generators and Transformers, Distribution of electricity to factory, college and to home. **(8 lectures)**

Electrical Wiring: Conductors and cables – its types, Basics of wiring. Voltage drop and losses across cables and conductors. Instruments to measure current, voltage, power in DC and AC circuits. Insulation. Solid and stranded cable. Conduit. Cable trays. Splices: wire nuts, crimps, terminal blocks, split bolts, and solder. Preparation of extension board. **(8 Lectures)**

Electrical Protection: Relays. Fuses and disconnect switches. Circuit breakers. Overload devices. Ground-fault protection. Grounding and isolating. Phase reversal. Surge protection. **(4 Lectures)**

Alternative power source: Inverter and UPS, online UPS and offline UPS, Solar inverter, Grid connection of solar energy. **(3 Lectures)**

Electric Motors: Single-phase, three-phase & DC motors. Basic principle and construction. Speed & power of ac moto, motor based electronic appliances- fan, mixer grinder, electronic vehicles. **(4Lectures)**
Electrical bulbs - Fluorescent lamps - street lighting - flood lighting water heater - storage and instant types, electric iron box, microwave oven - Stabilizer, fridge. **(3 Lectures)**

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

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

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PHY SE 0040(PRACTIRUM):: DISSERTATION ON ELECTRONICS

Credit: 1 (30 hours)

[redacted]

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

[redacted]

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

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

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

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

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PHY SE 0050: ELECTRIC AND HYBRID VEHICLES

Credit 2: Theory 2 (30 Lectures), Practical 1 (30 hours)

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

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

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

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

History of electronic vehicles (EV), comparison with the internal combustion engine, Introduction to electric and hybrid vehicles: Hybrid vehicle architectures, Series hybrid vehicle architectures- range extender and full hybrid systems, Parallel hybrid architectures, Plug-in hybrid architectures, commercially available electric and hybrid vehicles **(8 Lecturer)**

Propulsion System in EV, Basic Mechanics of a Vehicle, Energy consumed in a vehicle, Powertrain component sizing, Transmission configuration, components- electric motor, gears, brakes, regenerative braking. **(6 Lecturer)**

Driving cycles, Energy requirements, City cycle, highway cycle, and combined cycle (2 Lecturer) Fuel cell vehicles, Electric Motor Drive systems for EV/HEVs, Power Electronic converters for electric and hybrid vehicles. **(6 Lecturer)**

Energy Storage and management in EV: Battery energy storage-types of battery, Battery charging and range – types of charging technology, fast charging, supercapacitor and ultracapacitors, Energy management and control strategies, Hybrid vehicle control strategies **(6 lecturer)**

Benefits of owing an EV, various Govt. schemes and incentives, EVs on Indian roads, Challenges for EVs, Future of EVs **(4 Lecturer)**

1. Electric Vehicle Technology Explained by, Larminie James

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

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PHY SE 0050 (PRACTIRUM): PROJECT ON ELECTRONIC VEHICLES

Credit 1: (30 hr.)

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

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

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

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