Savitribai Phule Pune University

(Formerly University of Pune)

Three Year B.Sc. Degree Program in Physics

(Faculty of Science & Technology)

T.Y.B.Sc. (Physics)

Choice Based Credit System

To be implemented from Academic Year 2021-2022

PHY-356: Elective-I

T.Y.B.Sc. (Physics) (Sem-V)
PHY-356 Elective-I (A): Astronomy and Astrophysics-I

Lectures: 36 **(Credits-02)**

1: Fundamentals of Astronomy: **(10 L)**

Introduction: Components of the Universe; Stars, Planets, Asteroids, Meteors, Comets, Galaxies. Solar System: Age, Origin Basic measurements: Planetary orbits, distances, physical size, mass, density, temperature, rotation period determination, Co-ordinate system, Celestial hemisphere,

2: Astronomical Instruments: **(8 L)**

Optical telescopes, mounts, light gathering power, magnification, Resolution. Spectroscopes, CCD camera, photometer, filters Radio telescopes, Interferometry (only introduction)

3: Star Systems and basic observations: **(10 L)**

Stars life cycle, Stellar processes (Nuclear). Neutron stars, black holes, Chandrasekhar limit. Spectral classification of stars, O, B, A, F, G, K, M. Star Systems: Binaries / Cepheids / RR Lyrae, Observation of Sun: Eclipses, Moon, planets, meteor showers, transits, occultations.

4: Galaxies, Dark Matter and Dark Energy **(8 L)**

A) Galaxies, types, their formation, Hubble's tuning fork diagram, Open and Globular clusters, Dark Matter / Energy (evidence for both), Cosmology: Theories: BBT, Steady State, Oscillating Universe Theory.

B) Observational Astronomy: Concept of time, Magnitudes: apparent and absolute, introduction to Constellations, Star dial.

Reference books:

1. Astronomy structure of the Universe. A.E. Roy and D. Clarke, Adam Hilger Pub.
2. Source Book of Space Sciences, Samuel Galsstone; D.Van Nostrand Co. Inc
3. Astrophysics - Stars and Galaxies, K.D. Abhyankar, Tata McGraw Hill Pub.
4. Textbook of Astronomy and Astrophysics with elements of cosmology, V.B. Bhatia, Narosa Pub.
5. Structure of the Universe, J.V. Narlikar
6. Astrophysics, Baidyanath Basu.
7. Astrophysical Techniques, third Edition, C. R. Kitchin
8. Fundamentals of Astronomy, Michael Seed
9. Telescopes and techniques, C. R. Kitchin (Springer)

List of experiments: (Any 2)

1. Study of Binocular, refracting and reflecting telescopes and their mounts.
2. To determine the diameter of the Moon.
3. Measurement of Solar Constant.
4. Observation of emission, continuous and absorption spectra. (Mercury, sodium or iodine spectra could be obtained.)
5. Study of Construction and working of CCD.
6. Study of Solar Eclipse and Lunar Eclipse.

T.Y.B.Sc. (Physics) (Sem-V)
PHY-3510 SEC (H): Python Programming

Lectures: 36 **(Credits-02)**

Pre-requisite : Basic mathematics (XII-Science)
Version of python : 3.4
Proposed IDE : Spider, Py Charm or Jupyter

Python Programming:

Python is one of the top ten popular programming languages. Python is a general purpose and high level programming language. You can use Python for developing desktop GUI applications, websites and web applications. Also, Python, as a high level programming language, allows you to focus on core functionality of the application by taking care of common programming tasks. The simple syntax rules of the programming language further makes it easier for you to keep the code base readable and application maintainable. There are also a number of reasons why you should prefer Python to other programming languages.

Advantages of Python Programming

i.) Readable and Maintainable Code
ii.) Multiple Programming Paradigms
iii.) Compatible with Major Platforms and Systems
iv.) Robust Standard Library
v.) Many Open Source Frameworks and Tools
vi.) Simplify Complex Software Development
vii.) Adopt Test Driven Development

Objectives:

i.) To build foundation for understanding Python environment to enhance computational skills.
ii.) Understand variables, input and output functions in python and To Apply computational skill in problem solving approach of Physics
iii.) Get exposure to arithmetic, assignment, relational, logical and Boolean operators.
iv.) Be familiar with Python modules and Libraries

Course outcomes:

After completion of this course student will be able

i.) To write code for complex scientific computational requirement.
ii.) Use Libraries like NumPy for numeric computation
iii.) Use Library SciPy for scientific and technological calculations
iv.) Use Library Matplotlib for plotting of graph and its visualization.
v.) Develop own functions for Physics or mathematics.

Syllabus

a) Python Programming:

Unit No.	Topic	Lectures
1	**Introduction to Python Programming Language**: Introduction to Python Language, • Strengths and Weaknesses, • IDLE, Dynamic Types, • Naming Conventions, • String Values, • String Operations, • String Slices, • String Operators, • Numeric Data Types, • Conversions, • Built In Functions	03
2	**Data Collections and Language Component:** • Introduction, • Control Flow and Syntax, • Indenting, • The if Statement, • Relational Operators, • Logical, • Operators, • True or False, • Bit Wise Operators, • The while Loop, break and continue, • The for Loop, Lists, • Tuples, • Sets, • Dictionaries, • Sorting Dictionaries, • Copying Collections.	05
3	**Functions and Modules :** • Introduction • Defining Your Own Functions Parameters • Function Keyword and Optional Parameters • Passing Collections to a Function • Variable Number of Arguments Scope • Functions Passing Functions to a Function • Mapping Functions in a Dictionary	05

	• Modules • Standard Modules – sys • Standard Modules – math • Standard Modules – time • The dir Function	
5	**Modules and packages in Python :** • NumPy, SciPy • MathPlot etc	**05**

a) Demonstrations :

Sr. No.	Practical Demonstration to Communicate Concepts and Application in Physics, Electronics, Statistics and Mathematics
1	Write python program to use basic math and string operations.
2	Write python program to find roots of quadratic equation, prime numbers etc
3	Write python program to store data in list and perform matrix operation
4	Write python program to do numerical methods
5	Write python program involving tuples, dictionaries in problems related to physics or mathematical concepts
6	Write python program to use random number generator as probability density to show expected value is 0.5 to explain quantum mechanical behaviour of particle in one dimensional well.
7	Write python program to use NumPy library for more complex arithmetic operations
8	Write python program to use complex numbers and complex algebra
9	Write python program to use bitwise operation
10	Write python program to plot graphs using mathplotlib or similar library

Reference books:

- Python Programming: Using Problem Solving Approach. By Reema Thareja.
- Think Python By Allen Downey
- Problem Solving and Python Programming By Balguruswami McGrow Hill
- Let Us Python By Aditya Kanetkar
- Learning with Python By Allen Downey
- Data Analytics By Bharti Motwani

T.Y.B.Sc. (Physics) (Sem-V)
PHY-3510 SEC (I): Energy Studies

Lectures: 36 **(Credits-02)**

Course Objectives:

1. Students understand the comparative aspects, advantages and disadvantages of various sources of energy. They understand the facts and myths regarding the energy sources.
2. Students learn the basic principles involved and technologies developed in the uses of solar energy, biomass energy, wind energy, fuel cells.
3. Students understand the challenges and opportunities in conversion of energy from one form to another, generation of electricity and mechanical work using different energy sources.
4. Students get acquainted with challenges and recent trends in energy storage devices and they learn more about super-capacitors and batteries, electrical vehicles. They can imagine about future road maps in the fields of energy conversion and storage technologies.

Course Outcomes:

1. Students become capable of conducting energy audits and give consultancy in that field.
2. Students can design different types of solar heaters for small domestic as well as large scale community level applications.
3. Students acquire skills to implement solar P-V systems at domestic levels as well as for office premises and educational institutions. Students become able to start their own enterprise in net metering.
4. Students get ideas and hence become self-employed in the field of design , production, commissioning and implementation of bio-mass energy sources , bio-gas plants, gasifiers, wind mills, hybrid systems etc.
5. Students can go for research in the fields of super-capacitors, battery technologies, fuel cells and material synthesis for implementation of these technologies.
6. Students become successful entrepreneurs in the energy field.

Students strive to make the regions where they live and work self-sufficient in generating and fulfilling their own energy needs using different energy solutions.

Unit No.	Topic	Lectures
1	**An Introduction to Energy Sources:** Classification and comparison of energy sources (hydro, thermal, nuclear, solar, wind, biomass, and fossil fuels) considering environmental, safety, economy, production and distribution aspects. Facts and Myths about various sources of energy, thermal, nuclear sources of energy, Hybrid sources. Energy audit. Activity: 1. Energy audit of college campus/public campus/home/building 2. Comparison of energy sources. Visits to energy generation/distribution sites.	6
2	**Solar thermal Applications:** Sun as a source of energy, Solar Constant, Liquid flat plate collector, construction and working, Concentrating collectors, Solar drying, Solar water heating systems. Activity:	6

	1. Study of solar water heaters 2. Study of large scale solar heaters for industrial/cooking/water heating applications. 3. Study of flat plate, parabolic solar concentrators	
3	**Solar Photovoltaic systems Applications:** Photovoltaic principle, Power output and conversion efficiency, Limitation to photovoltaic efficiency, Basic photovoltaic system for power Generation, Application of solar photovoltaic systems, Advantages and disadvantages of Solar PV Systems. Configurations of Solar Photovoltaic Systems: Off-grid, Grid-Tied and Grid-Storage, Net metering and steps in installation of a rooftop solar PV System design. Activity: 1. Efficiency measurement of PV systems using I-V characteristics of Amorphous Si, Mono-crystalline Si, Polycrystalline Si in individual, series and parallel combinations. 2. Effect of intensity of incident light, incident angle and shading on Solar PV Module on Output power. 3. Study of design of solar lanterns, street lights using solar systems 4. Study of Installation and commissioning of roof top solar PV systems 5. Study of net metering systems	8
5	**Biomass and wind energy:** Bio-mass conversion technologies, Bio-gas generation, Working of biogas plant, Bio-gas from plant wastes, Methods for obtaining energy from biomass, Thermal gasification of biomass, Introduction to wind energy, Classification and description of wind machines, Wind energy, Wind data. Activity 1. Visit to bio gas plant 2. Visit to bio diesel plants 3. Study of modified bio mass plants 4. Design and implementation of domestic/small scale biogas plants. 5. Study of different types of gasifiers 6. Study of wind mill / visit to wind mill	8
	Energy storage devices and electrical Vehicles : Recent trends in batteries, super-capacitors, fuel cells. Applications of storage devices: Electrical Vehicles (EV), Converter, Inverter, Controls & Controllers in EV, Future Trends in Electric Cars. Activity 1. Preparation and testing of fuel cell on Laboratory scale 2. Preparation and testing of super capacitors on Laboratory scale 3. Preparation and testing of paper batteries and other types of batteries on Laboratory scale. 4. Design and implementation of battery-operated toys using green technology	8

Reference books:

1. Non-conventional Energy sources- G. D. RAI (4th edition), Khanna Publishers, Delhi
2. Solar Energy - S. P. Sukhatme (Second Edition), Tata Mc Graw Hill Ltd., New Delhi.
3. Solar Energy Utilisation - G. D. RAI (5th edition), Khanna Publishers, Delhi.

5.2 Ultrasonography
5.3 Ultrasonic Transducers
5.4 Ultrasonic cleaning, Non Destructive Testing (NDT)

Unit-6. Underwater Acoustics (2 L)

6.1 Speed of sound in sea water, Transmission loss
6.2 Sonar: Active and Passive Sonar

Activities: Any-6 **[18L]**

1. Frequency response of loudspeaker
2. Polar characteristics of a microphone
3. Study of Graphic Equalizer
4. Estimation and measurement of reverberation time
5. Expansion chamber mufflers Transmission Loss (TL)
6. Online calculators for Room Modes

Reference Books:

8. Fundamentals of Acoustics, L.E. Kinsler and A. R. Frey, Wiley Eastern
9. Audio and Video Systems, R. G. Gupta, Tata McGraw Hill, 2010
10. Acoustics, W.W. Seto, Schaum's Outline
11. Handbook of Sound Engineers, G.M. Ballou, Academic Press
12. Basic Acoustics, D.E. Hall, Oxford University Press
13. Design for good Acoustics and Noise Control, J.E. Moore, University Press

PHY-356: Elective-II

T.Y.B.Sc. (Physics) (Sem-VI)
PHY-366 Elective-II (P): Medical Electronics

Lectures: 36 **(Credits-02)**

1: Introduction: **(9L)**

1. 1 Terminology of medical instrumentation,
1.2 Physiological system of body
1.3 Sources of bioelectric signals,
1. 4 Origin of bioelectric signals,
1.5 Analysis of ECG pattern
1.6 Nernst equation
1.7 Various types of bioelectric signals,
1.8 Basic medical instrumentation system,
Problems
Ref: 1

2: Bio potential Electrodes and sensors: **(9L)**

2.1 Electrode-electrolyte interface,
2.2 Polarizable and non-polarizable electrodes,
2.3 Electrodes for ECG, EEG, EMG,
2.4 Resistive sensor
2.5 Capacitive sensor
2.6 Inductive sensor
2.7 Piezoelectric sensor
2.8 Temperature sensor
Problems
Ref: 2

3: Amplifiers and Signal Processing: **(9L)**

3.1 Introduction
3.2 Basic amplifier requirements
3.3 The Differential amplifier
3.4 Common mode rejection
3.5 Instrumentation amplifier
3.6 Isolation amplifier
3.7 Pateint safety
3.8 Cardiac monitor
Problems
Ref: 2

4: Measurements of Pressure and Volume Flow of Blood: **(9L)**

4.1 Direct measurements of blood pressure,
4.2 Indirect measurements of BP.
4.3 Heart sounds,

T.Y.B.Sc. (Physics) (Sem-VI)

PHY-366 Elective-II (T): Astronomy and Astrophysics-II

Lectures: 36 **(Credits-02)**

1: Astronomical Scales: **(10 L)**

Measurement of Astronomical Quantities, Astronomical Distances, Stellar Radii, Masses of Stars, Stellar Temperature, Measurement of Time, Sidereal Time, Apparent Solar Time, Mean Solar Time, Equation of Time, Astronomical Coordinate system (only introduction)

2: The Milky Way and Universe: **(8 L)**

Basic Structure and Properties of the Milky Way, Active Galaxies, Quasars and Radio Galaxies, Hubble's law with equation, its significance, Concept of space time, fate of our universe, Multiverse (only introduction)

3: The Stellar Phenomenon: **(10 L)**

Basic Composition of Interstellar Medium, Sun: Solar Cycle, Activity, Butterfly diagram, Photospheric phenomenon, Stars as distance estimators, Hydrostatic Equilibrium of a Star, Stellar models (only introduction).

4: Non-optical Astronomy: **(8 L)**

Basic parameters of an antenna, various types of antennas. UV, IR, X-ray and Gamma ray Telescopes, Detectors for optical and infrared regions. Orbiting space based telescopes: HST, Chandra.

List of Reference Books:

1. Astronomy structure of the Universe, A. E. Roy and D. Clarke, Adam Hilger Pub.
2. Source Book of Space Sciences, Samuel Galsstone; D.Van Nostrand Co. Inc
3. Astrophysics - Stars and Galaxies, K.D. Abhyankar, Tata McGraw Hill Pub.
4. Textbook of Astronomy and Astrophysics with elements of cosmology, V.B. Bhatia, Narosa Pub.
5. Structure of the Universe, J.V. Narlikar
6. Astrophysics, Baidyanath Basu.
7. Astrophysical Techniques, third Edition, C. R. Kitchin
8. Fundamentals of Astronomy, Michael Seed
9. Telescopes and techniques, C. R. Kitchin (Springer)

List of experiments: (Any Two)

1. To determine the temperature of an artificial star.
2. To observe the Fraunhofer lines in sunlight and determine the elements present.
3. To obtain the solar image on the screen and trace out the existing sunspots.
4. To locate and observe the various stars, constellation, planets. (At least 2 observation of each)
5. To polar Align an astronomical telescope.
6. To study the solar limb darkening effect.

T.Y.B.Sc. (Physics) (Sem-VI)

PHY-366 Elective-II (U): Renewable Energy Sources-II

Lectures: 36 **(Credits-02)**

1: Bioenergy and Biofuels: **(10L)**

Bioenergy:

1. Introduction to Bioenergy
2. Basic Routs: Biochemical, Thermochemical, Transesterification
3. Biochemical- Biogas generation/methanation
4. Biogas plant: Floating gas holder and fixed dome type biogas plant, construction and working
5. Factors affecting on bio-digestion (list of factors).
6. Thermochemical: Pyrolysis, Gasification, Carbonization
7. Transesterification:
8. Comparative study of floating gas holder and fixed dome type biogas plant.
9. Working of downdraft gasifier.
10. Various methods to obtain energy from biomass.

Biofuel:

1. Introduction to Biofuels
2. Production of Biofuels (Jatropa and Sugar cane bagasse)

Ref 1: 7.1, 7.2, 7.2.1, 7.2.2, 7.4, 7.5, 7.6, 7.7, 7.8, 7.11, 7.23, 7.24.1

Ref 2: 10.3 (page no 374 to 380)

2: Wind Energy **(08L)**

1. Introduction to wind energy.
2. Principles and components of wind energy conversion system.
3. Classification of wind machines: Horizontal axial machine and vertical axial machine.
4. Advantages and disadvantages of wind energy.
5. Wind data

Ref -1: 6.1, 6.2, 6.3, 6.5, 6.7, 6.8

3: Other Energy Sources: **(08L)**

1. Introduction to tidal and geothermal energy.
2. Tidal energy: methods of utilization of tidal energy.
3. Advantages and disadvantages of tidal power generation.
4. Geothermal energy: Geothermal sources and energy conversion.
5. Advantages and disadvantages of geothermal energy.
6. Introduction to Thermocell

Ref -1 (9.3), pages from 510-532),

Ref -1 (8), pages from 443, 470-476, 477) Ref -1 (11), pages from 609-657)

4: Energy Management: **(10L)**

1. Introduction to Energy Management (Definition, Principles etc)
2. Need of Energy Saving and Management
3. Different strategies of Energy Management
4. Role of Energy Managers and Auditors,

T.Y.B.Sc. (Physics) (Sem-VI)
PHY-3611 SEC (AB): Instrumentation for Agriculture

Lectures: 36 **(Credits-02)**

Objectives:

After completion of this course students can

1. Get knowledge of sensors used in agriculture field
2. Learn continuous and batch process
3. Learn greenhouse automation schemes
4. Learn Instrumentation in Irrigation

Course Outcomes:

After completion of this course student will

1. Able to test soil and water parameters.
2. Able to develop their own juice extract plant.
3. Able to developed their own green house

Syllabus:

Unit-1: Introduction **[02L]**

Necessity of instrumentation and control for agriculture, sensor requirement, remote sensing, bio sensors in agriculture.

Unit-2: Soil Properties & Sensing **[04L]**

Properties of soil: fundamentals definitions and relationship, index properties of soil, permeability & seepage analysis, shear strength, Mohr's circle of stress, active & passive earth pressures, stability & slopes,

Sensors: introduction to sonic anemometers, hygrometers, fine wire thermocouples, open & close path gas analyzers

Unit-3: Instrumentation in Continuous & Batch process **[04L]**

Flow diagram of sugar plant, sensors & instrumentation setup, Flow diagram of fermenter & control (batch process), flow diagram of dairy industry & instrumentation setup for it, Juice extraction control process & instrumentation setup.

Unit-4: Instrumentation in Irrigation **[04L]**

Water distribution and management control, Auto drip and sprinkler irrigation system, upstream & downstream control concept, SCADA for DAM parameters &control.

Unit-5: Greenhouse Parameters & Instrumentation **[04L]**

Greenhouse effect, Concept and construction of greenhouse, merits & demerits, ventilation, cooling & heating, wind speed, temperature & humidity, soil moisture, rain gauge, carbon dioxide enrichment measurement & control, Leaf area length *evapotranspiration*, temperature, wetness & respiration measurement & data logging, electromagnetic radiations photosynthesis.

Activity : any-6 **[18L]**

1) Measurement of water holding capacity of soil.
2) Measurement of soil texture.
3) Measurement of moisture contain in soil.
4) Micronutrients analysis of soil.
5) Measurement of physical properties of soil. (Color, odder, texture etc.)
6) Measurement of Chemical properties of soil (pH, chloride, Oxygen, Sulphur etc. contain in soil)
7) Measurement of Biological properties of soil (Fungi, Bacteria)
8) Air quality measurement.

9) Analysis of Residues in fruits.

10) Visit to green house.

11) Visit to Sugar industry/Juice extract plant/ dairy industry

Reference books:

1. Industrial instrumentation, "Patranabis", TMH.
2. Instrumentation handbook-process control, "B.G. Liptak", Chilton.
3. Process control and instrumentation technology, "C.D. Johnson", PHI
4. Wills B.A., " Mineral Processing Technology", 4th Ed., Pergamon Press
5. Principle of Farm Machinery, R.A Kepner, Roy Bainer;: CBS Publication
6. Agricultural Engineering; Radhey Lal: Saroj Publication
7. Environmental Engineering, Peary. II. S. and others