Deccan Education Society's

Fergusson College (Autonomous)
Pune

Learning Outcomes-Based Curriculum

for 3/4 years B.Sc. /B.Sc. (Honours) Programme

as per guidelines of

NEP-2.0

for

F. Y. B. Sc. (Physics)

With effect from Academic Year

2024-2025

Program Outcomes (POs) for B.Sc.	
PO1	**Disciplinary Knowledge:** Demonstrate comprehensive knowledge of the disciplines that form a part of a graduate programme. Execute strong theoretical and practical understanding generated from the specific graduate programme in the area of work.
PO2	**Critical Thinking and Problem solving:** Exhibit the skills of analysis, inference, interpretation and problem-solving by observing the situation closely and design the solutions.
PO3	**Social competence:** Display the understanding, behavioural skills needed for successful social adaptation, work in groups, exhibits thoughts and ideas effectively in writing and orally.
PO4	**Research-related skills and Scientific temper:** Develop the working knowledge and applications of instrumentation and laboratory techniques. Able to apply skills to design and conduct independent experiments, interpret, establish hypothesis and inquisitiveness towards research.
PO5	**Trans-disciplinary knowledge:** Integrate different disciplines to uplift the domains of cognitive abilities and transcend beyond discipline-specific approaches to address a common problem.
PO6	**Personal and professional competence:** Performing dependently and also collaboratively as a part of team to meet defined objectives and carry out work across interdisciplinary fields. Execute interpersonal relationships, self-motivation and adaptability skills and commit to professional ethics.
PO7	**Effective Citizenship and Ethics:** Demonstrate empathetic social concern and equity centred national development, and ability to act with an informed awareness of moral and ethical issues and commit to professional ethics and responsibility.
PO8	**Environment and Sustainability:** Understand the impact of the scientific solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.
PO9	**Self-directed and Life-long learning:** Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

PSO No.	Program Specific Outcomes(PSOs) Upon completion of this programme the student will be able to
PSO1	**Academic competence:** (i) **Develop** and **demonstrate** an understanding of the concepts related to heat, thermodynamic laws, electric field due to static charge distribution, Newtonian mechanics, wave properties of light, Newtonian mechanics, inertial and non-inertial frames of reference, radioactivity, elementary particles, quark model, physical systems from nano-scale to macroscopic scale, magnetostatics, Maxwell's equations and plane wave generation and quantum mechanical systems. Associate the fundamental concepts in physics and interpret information. (ii) **Demonstrate independent** thinking and scientific temper. **Categorize**, calculate and **solve** problems using concepts of physics.
PSO2	**Personal and Professional Competence:** (i) Carry out laboratory-oriented numerical calculations and be capable in data visualization and interpretation. Perform, demonstrate and analyse experimental work with suitable techniques in physics to study the phenomena related to light, scientific instruments, material process, electrical and electronics applications. (ii) Carry out the calculations in classical mechanics, quantum mechanics, mathematical methods and solids with advance techniques using computations and C-programming. (iii) Analyse experimental results and interpret graphs. (iv) Formulation of ideas, scientific writing and authentic reporting, effective presentation and communication skills through group discussion.
PSO3	**Research Competence:** (i) Apply Physics concepts of thermodynamics, mechanics, wave optics, electronics and nuclear physics in day to day life. Integrate core concepts studied in materials science, electronics, and optics during experimentations and projects. (ii) Integrate and explore techniques of synthesis, characterization of different materials and techniques of astronomical data analysis. Cultivate concepts of measurement techniques in physics and relate physics concepts in day to day life. (iii) Integrate core physics subjects during experimentation and projects. (iv) Apply numerical methods to solve various complex physical problems. (v) Identify and interpret research literature, formulate ideas, write reports and review articles related to all subjects in physics.
PSO4	**Entrepreneurial and Social competence:** Enhance and empower the students with their self-reliance capabilities through the understanding of advance techniques, use of programming language, material processing, mathematical and classical concepts, advancement of electronics ideas with reference to advance techniques with their industrial applications. (i) Employ experimental skills in industrial applications. (ii) Develop scientific temperament and social awareness through internships and science popularization. Awareness of ethical issues: emphasis on academic and research ethics. (iii) Outline the use of renewable sources for sustainable development of human beings. (iv) Execute social competence including effective use of computer languages to meet global competencies in technological world.

Semester	Paper Code	Paper Title	Type	Credits
I	**PHY-1001**	Mechanics	**Theory**	**2**
	PHY-1011	Physics Practical - 1	**Practical**	**2**
	PHY-1021 (OE-1)	Physics in Daily Life	**Theory**	**2**
II	**PHY-1002**	Heat and Thermodynamics	**Theory**	**2**
	PHY-1012	Physics Practical - 2	**Practical**	**2**
	PHY-1022 (OE-2)	Observational Astronomy	**Theory**	**2**
	PHY-1032 (SEC)	Basic Instrumentation Skills	**Theory/Practical**	**2**

Teaching and Evaluation (Only for FORMAL education courses)

Course Credits	No. of Hours per Semester Theory/Practical	No. of Hours per Week Theory/Practical	Maximum Marks	CE 40 %	ESE 60%
1	**15 / 30**	**1 / 2**	**25**	**10**	**15**
2	**30 / 60**	**2 / 4**	**50**	**20**	**30**
3	**45 / 90**	**3 / 6**	**75**	**30**	**45**
4	**60 / 120**	**4 / 8**	**100**	**40**	**60**

Eligibility: As per the rules and regulations of Savitribai Phule Pune University (SPPU)

F. Y. B. Sc. Semester I		
PHY-1011	**Physics Practical - 1**	**Credits:** 2 **Hours:** 60
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Identify various components, devices, instruments and tools for specific applications. Recall the theory associated with each experiment.	1
CO2	Illustrate skill of proper use of tools and test and measuring instruments.	2
CO3	Calculate the values of physical quantities using suitable instruments.	3
CO4	Explain the results by integrating the theory with experimental observations.	4
CO5	Evaluate various physical quantities and measure the errors therein.	5
CO6	Perform the experiments using proper procedures and specify the outcomes. Integrate the measuring instrumentation system with the experimental circuit as required.	6

Any 10 experiments: 8 compulsory + 1 Activity (Equivalent to Two Practical's)

Expt. No.	Title of the Experiment
1.	Measurements using Vernier Calliper and Spectrometer
2.	Measurements using Micrometer Screw Gauge and Travelling Microscope
3.	Use of digital multimeter (DMM) and Cathode Ray Oscilloscope (CRO)
4.	Moment of Inertia of a disc by torsional oscillations
5.	Moment of inertia of a flywheel
6.	'Y' by bending
7.	Y and η by Searles method
8.	Viscosity by flow through a capillary tube by Poiseuille's method
9.	Demo experiment I
10.	Demo experiment II

F. Y. B. Sc. Semester I		
PHY-1001	**Mechanics**	**Credits: 02 Hours: 30**
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO1	Identify the various physical parameters of mechanical systems.	1
CO2	Articulate the vectorial representation of various physical quantities of mechanics ex. Displacement, velocity, acceleration, momentum, forces, moments etc.	2
CO3	Apply the concepts of mechanics to different numerical problems in real world.	3
CO4	Explain the outcomes of real world problems.	4
CO5	Justify various mechanical system by using the different phenomenon of mechanics	5
CO6	Make models and demonstrate the same on the basis of concepts of mechanics.	6

Unit	Contents	No. of hours
I	**Fundamentals of Dynamics:** Reference frames. Inertial frames; Review of Newton's Laws of Motion. Momentum of variable-mass system: motion of rocket. Motion of a projectile in Uniform gravitational field. Dynamics of a system of particles. Centre of Mass. Principle of conservation of momentum. Impulse.	**6**
II	**Work and Energy:** Work and Kinetic Energy Theorem. Conservative and non-conservative forces. Potential Energy. Energy diagram. Stable and unstable equilibrium. Elastic potential energy. Force as gradient of potential energy. Work & Potential energy. Work done by non- conservative forces. Law of conservation of Energy	**4**
III	**Rotational Dynamics:** Angular momentum of a particle and system of particles. Torque. Principle of conservation of angular momentum. Rotation about a fixed axis. Moment of Inertia. Calculation of moment of inertia for rectangular, cylindrical and spherical bodies. Kinetic energy of rotation. Motion involving both translation and rotation.	**12**
IV	**Elasticity:** Relation between Elastic constants. Twisting torque on a Cylinder or Wire. **Fluid Motion**: Kinematics of Moving Fluids: Poiseuille's Equation for Flow of a Liquid through a Capillary Tube.	5
V	**Gravitation and Central Force Motion:** Law of gravitation. Gravitational potential energy. Inertial and gravitational mass. Potential and field due to spherical shell and solid sphere. Motion of a particle under a central force field. Two-body problem and its reduction to one-body problem and its solution. The energy equation and energy diagram. Kepler's Laws. Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system (GPS).	**9**

References

1. An introduction to mechanics, D. Kleppner, R. J. Kolenkow, 1973, McGraw-Hill.
2. Mechanics, Berkeley Physics, vol.1, C. Kittel, W. Knight, et.al. 2007, Tata McGraw-Hill.
3. Analytical Mechanics, G. R. Fowles and G. L. Cassiday. 2005, Cengage Learning
4. Feynman Lectures, Vol. I, R. P. Feynman, R. B. Leighton, M. Sands, 2008, Pearson Education
5. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
6. Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000
7. University Physics. F.W Sears, M.W Zemansky, H.D Young 13/e, 1986, Addison Wesley
8. Physics for scientists and Engineers with Modern Phys., J. W. Jewett, R. A. Seray, 2010, Cengage Learning
9. Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.
10. Concepts of Physics, Vol I: H. C. Varma, Bharati Bhavan Publishers

F. Y. B. Sc. Semester I		
PHY-1021 (OE-1)	**Physics in Daily Life (OE-1 Theory)**	**Credits:** 2 **Hours:** 30
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO1	Recall, understand, use and apply the scientific knowledge set out in the syllabus.	1
CO2	Learn, recognize and apply basic physical principles related to climate, human body and Technology:	2
CO3	Learn about earth's atmosphere and related phenomena.	3
CO4	Solve simple physics related problems. Apply the simple law of nature to different fields of science, engineering and technology.	4
CO5	Evaluate relevant scientific information and make informed judgements about it	5

Learning outcomes

1. Every student will be able to study physics on a deeper level and to uses basic physics concepts to navigate everyday life.
2. Every student will be able to build essential scientific knowledge and skills for life-long learning.

Unit	Contents	No. of hours
I	**Physics in Earth's Atmosphere** Sun, Earth's atmosphere as an ideal gas; Pressure, temperature and density, Pascal's Law and Archimedes' Principle, Corioli's acceleration and weather systems, Rayleigh scattering, the red sunset, Reflection, refraction and dispersion of light, Total internal reflection, Rainbow.	**10**
II	**Physics in Human Body and Sports** The eyes as an optical instrument, Vision defects, Rayleigh criterion and resolving power, Sound waves and hearing, Sound intensity, Decibel scale, Energy budget and temperature control, Physics in Sports: The sweet spot, Dynamics of rotating objects, Running, Jumping and pole vaulting, Motion of a spinning ball, Continuity and Bernoulli equations, Turbulence and drag.	**10**
III	**Physics in Technology** Microwave ovens, Lorentz force, Global Positioning System, CCDs, Lasers, Displays, Optical recording, CD, DVD Player, Tape records, Electric motors, Hybrid car, Telescope, Microscope, Projector etc.	**10**

References:

1. H. C. Verma, Concepts of Physics (Bharati Bhawan publishers and distributers, New Delhi, India) 2011.
2. Sears and Zeemansky, University Physics (Addison Wesley, Boston, USA) 2007.
3. B. Lal and Subramaniam, Electricity and Magnetism (Ratan Prakashan Mandir, Agra, India) 2013.
4. Physics in Daily Life, Jo Hermans, EDP Sciences
5. E. Hecht, Optics (Addison Wesley, Boston, USA) 2001.
6. M. Nelkon and P. Parker, Advanced Level Physics (Heinemann International, London, U.K.) 2012.
7. How Things Work, The Physics of Everyday Life, Louis A. Bloomfield, Wiley, 2013.

F. Y. B. Sc. Semester II		
PHY-1002	**Heat and Thermodynamics**	**Credits: 02 Hours: 30**
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO1	Recall and describe the concepts of Thermodynamics.	1
CO2	Discuss the behaviour of real gases and ideal gases.	2
CO3	Compute the thermodynamic quantities associated with different types of processes.	3
CO4	Explain concepts of Thermodynamics and Kinetic theory of gases to elaborate deviations from ideal behaviour in real gases.	4
CO5	Determine and compare the efficiency of heat engines.	5
CO6	Integrate the knowledge of Thermodynamics and Kinetic theory to solve problems.	6

Unit	Contents	No. of hours
I	**Introduction to Thermodynamics** Zeroth and First Law of Thermodynamics: Extensive and intensive Thermodynamic Variables, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics & Concept of Temperature, Concept of Work & Heat, State Functions, First Law of Thermodynamics and its differential form, Internal Energy, First Law & various processes, Applications of First Law: General Relation between C_P and C_V, Work Done during Isothermal and Adiabatic Processes.	**8**
II	**Real Gases**: Behaviour of Real Gases: Deviations from the Ideal Gas Equation. The Virial Equation. Andrew's Experiments on CO_2 Gas. Critical Constants. Boyle Temperature. Van der Waal's Equation of State for Real Gases. Values of Critical Constants. Law of Corresponding States. Comparison with Experimental Curves. P-V Diagrams. Joule's Experiment. Free Adiabatic Expansion of a Perfect Gas. Joule-Thomson Porous Plug Experiment. Joule-Thomson Effect for Real and Van der Waal Gases. Temperature of Inversion. Joule-Thomson Cooling.	**8**
III	**Second Law of Thermodynamics:** Reversible and Irreversible process with examples. Conversion of Work into Heat and Heat into Work. Heat Engines (Otto engine, Diesel engine), Carnot's Cycle, Carnot engine & efficiency. Refrigerator & coefficient of performance, 2^{nd} Law of Thermodynamics: Kelvin-Planck and Clausius Statements. Carnot's Theorem. Temperature Scales (Centigrade, Fahrenheit and Kelvin scale), Principle, construction and working of following thermometers: Mercury in glass, Resistance thermometers, Thermocouple.	**8**
IV	**Entropy**: Concept of Entropy, Clausius Theorem. Second Law of Thermodynamics in terms of Entropy. Entropy of a perfect gas. Principle of Increase of Entropy. Entropy Changes in Reversible and Irreversible processes with examples. Entropy of the Universe. Temperature–Entropy diagrams for Carnot's Cycle. T-dS Equation, Clausius- Clapeyron latent heat equations.	6

References

1. Heat and Thermodynamics and Statistical Physics, Brij Lal, Dr. N. Subrahmanyam, P. S. Hemne, S. Chand Publications
2. Concepts of Physics, Vol I: H. C. Varma, Bharati Bhavan Publishers
3. Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill.
4. A Treatise on Heat, Meghnad Saha, and B. N. Srivastava, 1958, Indian Press
5. Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill
6. Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer
7. Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa.
8. Concepts in Thermal Physics, S.J. Blundell and K.M. Blundell, 2nd Ed., 2012, Oxford University Press.
9. Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. Chand Publications.
10. Thermal Physics, B.K. Agrawal, Lok Bharti Publications.

F. Y. B. Sc. Semester II		
PHY-1012	**Physics Practical - 2**	**Credits:** 2 **Hours:** 60
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Identify various components, devices, instruments and tools for specific applications. Recall the theory associated with each experiment.	1
CO2	Illustrate skill of proper use of tools and test and measuring instruments.	2
CO3	Calculate the values of physical quantities using suitable instruments.	3
CO4	Explain the results by integrating the theory with experimental observations.	4
CO5	Evaluate various physical quantities and measure the errors therein.	5
CO6	Perform the experiments using proper procedures and specify the outcomes. Integrate the measuring instrumentation system with the experimental circuit as required.	6

Any 10 experiments: 8 compulsory + 1 Activity (Equivalent to Two Practical's)

Expt. No.	Title of the Experiment
1.	Determination of frequency of A. C.
2.	Thermal conductivity by Lee's method
3.	Calibration of Thermocouple
4.	Study and calibration of the spectrometer
5.	Surface Tension by Jaegers method
6.	Plotting of graph and analysis using linear regression (Line and Exponential)
7.	Specific heat of water
8.	Temperature coefficient of resistance (PTC and NTC)
9 & 10	Study Visit

F. Y. B. Sc. Semester II		
PHY-1022 (OE-2)	**Observational Astronomy (OE-2 Theory)**	**Credits:** 2 **Hours:** 30
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO1	Describe the Physical universe and identify constellations, stars, planets, on the celestial sphere.	1
CO2	Understand the basic properties of light, fundamentals of human vision and apply it to astronomical observations using binoculars and telescopes.	2
CO3	Demonstrate the ability to use star charts and stellarium.	3
CO4	Distinguish between the concept of universal and local time, sidereal and synodic months, solar and lunar eclipses.	4
CO5	Measure astronomical distances of planets and stars.	5
CO6	Plan meteor shower observations using stellarium and sky charts and locate objects in the sky.	6

Unit	Contents	No. of Hours
I	**Distances and Measurements** Celestial Sphere, Celestial Co-Ordinate System, Astronomical Unit, Red shift, Magnitude Scale	**8**
II	**Solar System** Planets and their orbits, Asteroids, Comets, Moon phases, Tides and types of Eclipses.	**7**
III	**Telescopes and Detectors** Types of Telescopes, Types of Mounts, Types of Detectors, Eye as Detector	**7**
IV	**Observation and Imaging** Use of Stellarium, Imaging of celestial objects with CCD, DSLR and Photometer, Atmospheric effects and limitations, Differential Photometry	**8**

References

1. Electronic Imaging in Astronomy: Detectors and Instrumentation by Ian S. McLean, Publication: Spinger
2. Practical Astronomy with Your Calculator by Peter Duffett-Smith by Cambridge University Press
3. Observational Astrophysics by R. C. Smith, Publication Cambridge University Press
4. Astronomical Techniques by W. A. Hiltner (Ed), Publication: Cambridge University Press
5. Astronomical Photometry by Henden and Kaitchuck, Publication: Van Nostrand Reinhold

F. Y. B. Sc. Semester II		
PHY-1032 (SEC)	**Basic Instrumentation Skills (SEC-Theory)**	**Credits:** 2 **Hours:** 30
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO1	Identify different type of Analog and Digital instruments.	1
CO2	Interpret the principle of operation of various instruments.	2
CO3	Apply the principles of operations of various instruments to measure physical quantities.	3
CO4	Explain the working of various measuring instruments like CRO, Multi-meter, etc	4

This course is to get exposure with various aspects of instruments and their usage through hands-on mode.

Skills to be learned

1] Develop skills to use basic electrical instruments like multimeter, cathode ray oscilloscope.
2] Acquire efficiency in making signal generators and analysis of obtained signals.
3] Learn to understand and use various types of digital instruments.
4] Develop knowledge of making measurements with instruments.

Unit	Contents	No. of hours
I	**Basic of Measurement:** Instruments accuracy, precision, sensitivity, resolution range etc. Errors in measurements Multimeter: Principles of measurement of dc voltage and dc current, ac voltage, ac current and resistance. Specifications of a multimeter and their significance.	**6**
II	**Cathode Ray Oscilloscope:** Block diagram of basic CRO. Construction of CRT, Electron gun, electrostatic focusing and acceleration (Explanation only– no mathematical treatment), brief discussion on screen phosphor, visual persistence &chemical composition. Time base operation, synchronization. Front panel controls. Specifications of a CRO and their significance. Use of CRO for the measurement of voltage (dc and ac frequency, time period. Special features of dual trace, introduction to digital oscilloscope, probes. Digital storage Oscilloscope: Block diagram and principle of working.	**12**
III	**Signal Generators and Analysis Instruments:** Block diagram, explanation and specifications of low frequency signal generators. pulse generator, and function generator. Brief idea for testing, specifications. Distortion factor meter, wave analysis.	**5**
IV	**Digital Instruments:** Principle and working of digital meters. Comparison of Analog & digital instruments. Characteristics of a digital meter. Working principles of digital voltmeter. Digital Multimeter: Block diagram and working of a digital multimeter. Working principle of time interval, frequency and period measurement using universal counter/frequency counter, time- base stability, accuracy and resolution.	**7**

References

1. Basic Electronics solid state - B L Theraja - S Chand and Co.
2. Performance and design of AC machines - M G Say ELBS Edn.
3. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
4. Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
5. Electronic Devices and circuits, S. Salivahanan& N. S. Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill