Deccan Education Society's

Fergusson College (Autonomous)

Pune

Learning Outcomes-Based Curriculum

for

F. Y. B. Sc. Physics

With effect from June 2019

Program Outcomes (POs) for B.Sc. Programme	
PO1	**Disciplinary Knowledge:** Demonstrate comprehensive knowledge of the disciplines that form a part of an 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.

Programme structure

Year	Course Code	Title of the Course	Core / Elective	No. of Credits
F. Y. B. Sc.	**Semester I**			
	PHY1101	Mechanics and Properties of matter	CORE-1	2
	PHY1102	Heat and thermodynamics	CORE-2	2
	PHY1103	Physics Practical - I	PCORE-1	2
	Semester II			
	PHY1201	Introduction to Mathematical Physics	CORE-3	2
	PHY1202	Electricity and Magnetism	CORE-4	2
	PHY1203	Physics Practical - II	PCORE-2	2

Year	Paper Code	Title of Paper	No. of Credits
S. Y. B. Sc.	**Semester III**		
	PHY2301	Oscillations, Waves and Sound	2
	PHY2302	Principles and Applications of Optics	2
	PHY2303	Practical Practical - III	2
	Semester IV		
	PHY2401	Introductory Quantum Physics and Relativity	2
	PHY2402	Measurement Techniques in Physics	2
	PHY2403	Practical Practical - IV	2

Year	Paper No.	Course Code	Title	Credits	CE Max Marks	ESE Max Marks	Total Max Marks
T.Y. B.Sc.	**Semester V**						
	DSE-1A	PHY3501	Mathematical Methods in Physics	2	50	50	100
	DSE-1B	PHY3502	Solid States of Physics	2	50	50	100
	DSE-2A	PHY3503	Classical Mechanics	2	50	50	100
	DSE-2B	PHY3504	Atomic and Molecular Physics	2	50	50	100
	DSE-3A	PHY3505	Elements of Materials Science	2	50	50	100
	DSE-3B	PHY3506 PHY3513 PHY3514	**Elective I (Select any One)** LASERS **OR** Radiation Physics **OR** Biophysics	2	50	50	100
	DSE-1	PHY3507	Physics Practical – I	2	50	50	100
	DSE-2	PHY3508	Physics Practical – II	2	50	50	100
	DSE-3	PHY3509	Physics Practical – III	2	50	50	100
	SEC-1*	PHY3511	Analog Electronics	2	50	50	100
	SEC-2*	PHY3512	Numerical Analysis	2	50	50	100

Year	Paper No.	Course Code	Title	Credits	CE Max Marks	ESE Max Marks	Total Max Marks
T.Y. B.Sc.	**Semester VI**						
	DSE-1A	PHY3601	Classical Electrodynamics	2	50	50	100
	DSE-1B	PHY3602	Quantum Mechanics	2	50	50	100
	DSE-2A	PHY3603	Thermodynamics and Statistical Mechanics	2	50	50	100
	DSE-2B	PHY3604	Nuclear Physics	2	50	50	100
	DSE-3A	PHY3605	Astronomy & Astrophysics	2	50	50	100
	DSE-3B	PHY3606 PHY3613 PHY3614	**Elective II (Select any One)** Energy Studies **OR** Biomedical Instrumentation **OR** Physics of Nanomaterials	2	50	50	100
	DSE-1	PHY3607	Physics Practical – IV	2	50	50	100
	DSE-2	PHY3608	Physics Practical – V	2	50	50	100
	DSE-3	PHY3609	Physics Practical - VI **(Project)**	2	50	50	100
	SEC-1*	PHY3611	Digital Electronics	2	50	50	100
	SEC-2*	PHY3612	C-programming	2	50	50	100

F.Y. B.Sc. Semester I		
Title of the Course and Course Code	**Mechanics and Properties of matter (PHY1101)**	**Number of Credits : 02**

Course Outcomes (COs)

On completion of the course, the students will be able to:

CO1	Identify fundamental principles in mechanics.
CO2	Illustrate Newton's laws of gravitation and Kepler's laws of planetary motion. Explain viscosity of Fluid, law of energy conservation and applications of Bernoulli's theorems with examples.
CO3	Apply the physical principles of moment of inertia in terms of the mass distribution from the rotational axis to various symmetrical bodies.
CO4	Analyse the properties and applications of elasticity with experiments.
CO5	Justify the quantitative problem-solving skills in all the topics covered.
CO6	Develop an intuition towards problems solving and design realistic applications in the physical world.

Unit. No.	Title of Unit and Contents	No. of Lectures
I	**Moment of Inertia** **Moment of Inertia:** Definition of MI, Radius of gyration, Statement of parallel and perpendicular axis theorems. Derivation of MI of: Circular Ring, Circular Disc, Annular Ring, Spherical shell & solid sphere, Hollow cylinder & Solid cylinder, Flywheel, axel & its Applications, Spring **Gyroscope:** Principal, construction, working and applications	10
II	**Gravitation:** Newton's law of gravitation**,** Gravitational force, Gravitational field and Gravitational potential, Gravitational potential energy of a multi-particle system, uniform solid sphere and galaxy**,** Central force, Kepler's laws of planetary motion	8
III	**Elasticity:** Basic concepts of elasticity, Hook's law, three types of elastic moduli, Poisson's ratio, Relationship between Y, k, η. Bending of beam, bending moment, cantilever load at free end, loaded uniformly, due to its own weight. Determination of Y by bending of a uniformly loaded beam. Determination of elastic constant using Searle's method	8

IV	**Fluid Mechanics:** Laminar and viscous flow, viscosity, Coefficient of viscosity, Streamline flow and Turbulent flow (Tubular flow), Equation of continuity of flow, Energy of fluid. Bernoulli's theorem (Steady flow), Euler's equation, Applications of Bernoulli's theorem: Venturi meter, Pitot tube, Aerofoil, Bunsen burner, Atomizer, Spinning of a ball. Critical velocity and Reynold's number	10

References:

1. University Physics: Sears and Zeemansky, XIIth edition, Pearson Education
2. Physics: Volume I, Resnick/Halliday/Krane John Wiley & Sons (Sea) pvt ltd. 4th edition.
3. Properties of Matter: D. S. Mathur, Shamlal Charitable Trust New Delhi
4. Mechanics: D. S. Mathur, S. Chand and Company New Delhi.
5. Concepts of Physics, Vol I: H. C. Varma, Bharati Bhavan Publishers

Title of the Course and Course Code	**Heat and Thermodynamics (PHY1102)**	**Number of Credits : 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Recall the concepts of Thermodynamics.	
CO2	Discuss the behaviour of real gases.	
CO3	Compute the thermodynamic quantities associated with different types of processes.	
CO4	Explain the working of heat engine, different types of thermometers. Compare types of heat engines and their working; temperature scales.	
CO5	Determine work done, efficiency of heat engines and coefficient of performance of refrigerators, temperatures using different scales and principles of thermometers.	
CO6	Specify the different types of thermodynamic processes in daily life.	

Unit. No.	**Title of Unit and Contents**	**No. of Lectures**
I	**Concepts of Thermodynamics:** Thermodynamic state of a system and zeroth law of thermodynamics, Thermodynamic Equilibrium, Adiabatic and isothermal changes, Work done during isothermal changes, Adiabatic relations for perfect gas, Work done during adiabatic change, Indicator Diagram, First law of Thermodynamics, Reversible and Irreversible processes	8

II	**Applied Thermodynamics:** Conversion of heat into work and its converse, Carnot's cycle and Carnot's heat engine and its efficiency, Second law of Thermodynamics, Concept of entropy, Temperature Entropy diagram, T-dS Equation, Clausius- Clapeyron latent heat equations	8
III	**Heat Transfer Mechanisms:** Heat Engines (Otto cycle and its efficiency, Diesel cycle and its efficiency), Refrigerators (General principle and coefficient of performance of refrigerator, The Carnot refrigerator, Simple structure of vapour compression refrigerator), Air conditioning principle and its applications	8
IV	**Equation of state:** Equations of state, Andrew's experiment, Amagat's experiment**,** Van der Waals' equation of state**,** Critical constants**,** Reduced equation of state, Joule-Thomson porous plug experiment	8
V	**Thermometry:** Temperature Scales (Centigrade, Fahrenheit and Kelvin scale), Principle, construction and working of following thermometers (Liquid and gas thermometers, Resistive type thermometers, Thermocouple as thermometer, Pyrometers)	4

References:

1. Physics: Volume I, Resnick/Halliday/Krane John Wiley & Sons (Sea) pvt ltd
2. Sears and Zemansky's University Physics, 12th Edition, H. D. Young, R. A. Freedman, A. L. Ford,F. W. Sears, Pearson Education
3. Concept of Physics Vol II: H. C. Verma, Bharati Bhavan Publishers
4. Heat and thermodynamics: Singhal, Agarwal and Prakash.
5. Heat and Thermodynamics: Brijlal, N. Subrahmanyam, S. Chand & Company Ltd, New Delhi

Title of the Course and Course Code	Physics Practical – I (PHY 1103)	Number of Credits : 02
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Identify various components, devices, instruments and tools for specific applications. Recall the theory associated with each experiment.	
CO2	Illustrate skill of proper use of tools and test and measuring instruments.	
CO3	Calculate the values of physical quantities using suitable instruments.	
CO4	Explain the results by integrating the theory with experimental observations.	
CO5	Evaluate various physical quantities and measure the errors therein.	
CO6	Perform the experiments using proper procedures and specify the outcomes. Integrate the measuring instrumentation system with the experimental circuit as required.	

Sr. No.	Title of Experiment
1	Measurement of least count of various instruments
2	Moment of Inertia of a disc by torsional oscillations
3	Viscosity by flow through a capillary tube by Poiseuille's method
4	'Y' by bending
5	Plotting of graph and analysis
6	Moment of inertia of a flywheel
7	Calibration of thermocouple
8	Thermal conductivity by Lee's method
9	Demo experiment I
10	Demo experiment II

F.Y. B.Sc. Semester II		
Title of the Course and Course Code	**Introduction to Mathematical Physics (PHY1201)**	**Number of Credits : 02**

Course Outcomes (COs)

On completion of the course, the students will be able to:

CO1	Define complex numbers.
CO2	Explain the importance of gradient, divergence and curl.
CO3	Solve vector identities.
CO4	Relate complex number operations with the help of diagrams.
CO5	Evaluate the angular velocity using vectors.
CO6	Compile the equations studied with complex and differential equations.

Unit. No.	Title of Unit and Contents	No. of Lectures
I	**Complex Numbers:** Introduction to Complex Numbers, Algebra of Complex Numbers, Argand diagram, Algebra of complex numbers using Argand Diagram, Rectangular, polar and exponential forms of complex Numbers, Demibra's theorem (statement only), Trigonometric, hyperbolic and exponential functions, Powers, roots and log of complex numbers, Application of complex numbers to determine velocity and acceleration in curved motion. *Problems*	10
II	**Vector Analysis:** Differentiation of vectors with respect to scalars, Scalar and vector fields, Vector differential operators, Gradient of scalar field and its physical significance, Curl of vector field and its physical significance, Vector integrals (line, surface and volume integral with their examples), Statements of Gauss divergence theorem and Stoke's theorem. **Vector identities:** $\nabla \times \nabla\emptyset = 0$ $\nabla \cdot (\nabla \times V) = 0$ $\nabla \cdot (\nabla\emptyset) = \nabla^2\emptyset$ $\nabla \cdot (\emptyset A) = \nabla\emptyset \cdot A + \emptyset(\nabla \cdot A)$ $\nabla \times (\emptyset A) = \emptyset(\nabla \times A) + (\nabla\emptyset) \times A$ $\nabla(\mathrm{A} \times B) = B \cdot (\nabla \times A) - A \cdot (\nabla \times B)$	8

III	**Partial Differentiation:** Definition of partial differentiation, Successive differentiation, Total differentiation, Exact differential, Chain rule, Theorems of differentiation, Change of variables from Cartesian to polar co-ordinates, Implicit and explicit functions, Conditions for maxima and minima (without proof) *Problems*	8
IV	**Applications of differential equations:** **First order differential equations:** Growth and decay (Charging and discharging in CR Circuit, LR circuit, Radioactive decay, Population problems), Temperature Problems (Cooling of a body), Falling Body Problems (Equation of Motion for velocity and position of the body when all resistance is proportional to velocity of body) **Second order differential equations:** Simple Harmonic Oscillator, LCR Circuit, Buoyancy	10

References:

1. Mathematical Physics, B. D. Gupta, Pragati Prakashan, Meerut
2. Mathematical Methods in Physical Science, Mary L. Boas, Wiley Publications
3. Schaum's Outline of Vector Analysis, Murray R. Spiegel, McGraw Hill Professional
4. Theory and Problems of Differential Equations (Schaum's Outline Series), Bronson, Tata McGraw-Hill Education

Title of the Course and Course Code	**Electricity and Magnetism (PHY1202)**	**Number of Credits : 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Recall the concepts associated with stationary charges.	
CO2	Discuss the atomic view of polarization of matter. Explain the correlation in electricity and magnetism.	
CO3	Compute the boundary conditions and calculate quantities like current, voltage, power, phase, impedance, etc in DC and AC circuits.	
CO4	Classify the phase relations in AC circuits.	
CO5	Compare the growth and decay of current in DC circuits.	
CO6	Write the phase relations between different parameters (like current, voltage, power and impedance) in simple electronic circuits comprising of resistors, inductors and capacitors.	

Unit. No.	Title of Unit and Contents	No. of Lectures
I	**Dielectrics:** Polarization of matter (Atomic view, Induced charges, Free charges and bound charges), Polarization charges and dipole moment, Electric susceptibility and polarization vector, Electric displacement and examples, Gauss's law in dielectrics, Boundary conditions at dielectric surface	10
II	**D C circuits:** Growth and decay of current in R-L circuit, Growth and decay of current in L-C circuit, L-R-C series circuit	6
III	**A C circuits:** Phasors, Resistance and Reactance, L-R-C series circuit, Power in AC circuit, Resonance in AC circuit,	10
IV	Magnetism in matter: Ampere's circuit law and it's applications, Gauss law for magnetism, Magnetic Materials (Ferro magnetic, Paramagnetic, diamagnetic), Cause of magnetization (Spin magnetic moment and orbital magnetic moment, Bohr magneton), Concepts of **H**, **B**, **M**, χ, μ, Relation between **B**, **H**, **M**, Hysteresis	10

References:

1. Fundamentals of electricity and Magnetism, Arthur Kip, McGraw-Hill
2. Sears and Zemansky's University Physics, 12th Edition, H. D. Young,R. A. Freedman,A. L. Ford,F. W. Sears, Pearson Education

Title of the Course and Course Code	Physics Practical - II(PHY 1203)	Number of Credits : 02
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Identify various components, devices, instruments and tools for specific applications. Recall the theory associated with each experiment.	
CO2	Illustrate skill of proper use of tools and test and measuring instruments.	
CO3	Calculate the values of physical quantities using suitable instruments.	
CO4	Explain the results by integrating the theory with experimental observations.	
CO5	Evaluate various physical quantities and measure the errors therein.	
CO6	Perform the experiments using proper procedures and specify the outcomes. Integrate the measuring instrumentation system with the experimental circuit as required.	

Sr. No.	Title of Experiment
1	Determination of frequency of A. C.
2	Study of LCR circuit
3	Verification of circuit theorems
4	Study and calibration of spectrometer
5	Charging, discharging of capacitor
6	L-R circuit: Vector diagram and power factor
7	Diode characteristics
8	Temperature coefficient of resistance
9 & 10	Study visit