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-2020

for

S. 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	**arch-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	**ıs-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.

Fergusson College (Autonomous), Pune
Proposed First Year Curriculum as per NEP 2020

Department of Physics

S. Y. B. Sc. Structure for Major / Minor

Semester	Paper Code	Paper Title	Type	Credits
III	**PHY-200 (MAJOR)**	Physics Practical - 3	**Practical**	**2**
	PHY-201 (MAJOR)	Oscillations, Waves and Optics	**Theory**	**4**
	PHY-211 (MINOR)	Oscillations and Optics	**Theory**	**2**
	PHY-212 (MINOR)	Physics Practical - 3	**Practical**	**2**
	PHY-220 (OE)	Introduction to Nanoscience	**Theory**	**2**
	PHY-230 (VSC)	Electrical circuit and network skills	**Theory**	**2**
	PHY-240 (SEC)	Renewable Energy and Harvesting	**Theory**	**2**
	PHY-245 (CEP)	Community Engagement Program	**CEP**	**2**
	VPH-230 (VSC)	Basics of Photography	**Theory**	**2**
			Total	**18**
IV	**PHY-250 (MAJOR)**	Physics Practical - 4	**Practical**	**2**
	PHY-251 (MAJOR)	Electricity and Magnetism	**Theory**	**4**
	PHY-261 (MINOR)	Basics of Electricity and Magnetism	**Theory**	**2**
	PHY-262 (MINOR)	Physics Practical - 4	**Practical**	**2**
	PHY-270 (OE)	Meteorology	**Theory**	**2**
	PHY-280 (VSC)	Python Programming	**Theory**	**2**
	PHY-290 (SEC)	Solar PV Systems	**Theory**	**2**
	PHY-295 (FP)	Field Project	**FP**	**2**
	VPH-280 (VSC)	Image Processing & Graphic Design	**Theory**	**2**
			Total	**18**

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)

SEMESTER III

S. Y. B. Sc. Semester III		
PHY-200	**Physics Practical-3**	**Credits: 2 Hours: 60**
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO1	Recall the use of instruments for measuring the various physical parameters.	1
CO2	Arrange various instruments like coupled pendulums, polarimeters, diffraction gratings, and Newton's rings apparatus for accurate experiment measurements.	2
CO3	Carry out various experiments based on the phenomenon of waves and optics.	3
CO4	Explain the results obtained from various experiments.	4
CO5	Evaluate various physical quantities and compute the errors therein.	5
CO6	Perform experiments using proper procedures, specifying outcomes, and integrating the measuring instrumentation system.	6

Expt. No.	Title of the Experiment
1.	Log decrement of an oscillator in air and water
2.	Study of coupled oscillations using Coupled Pendulum
3.	'g' by Bar Pendulum
4.	Kater's pendulum
5.	Study of Lissajous figures
6.	Absorption coefficient of sound
7.	Study of Double refraction using prism
8.	The specific rotation of sugar solution by a half-shade polarimeter
9.	Determination of wavelength of light and thickness of wire using diffraction pattern
10.	Determination of the radius of curvature of a lens using Newton's rings
11.	Demonstration Experiment 1
12.	Demonstration Experiment 2
Any 10 experiments: 8 Experiments + 2 Demonstrations need to be performed	

S. Y. B. Sc. Semester III		
PHY-201	**Oscillations, Waves and Optics**	**Credits:04 Hours: 60**
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO1	Identify various physical phenomena and parameters related to oscillations, wave and optics.	1
CO2	Illustrate the mathematical treatment of various concepts of oscillations, waves and optics.	2
CO3	Apply the concepts of oscillations, waves and optics to different numerical problems.	3
CO4	Explain the outcomes of real-world problems.	4
CO5	Justify various system by using the different phenomenon of oscillations, waves and optics	5
CO6	Demonstrate concepts of oscillations, waves and optics through models and experiments.	6

Unit. No.	Title of Unit and Contents	No. of Lectures
I	**Undamped and Damped Oscillations:** **Undamped Oscillations** Differential equation of S.H.M. and its solution (exponential form) Composition of two perpendicular linear S.H.M.s in frequency ratio 1:1 and 1:2 (analytical method) Compound Pendulum, Bar Pendulum, Kater's Pendulum. **Damped oscillation** Differential equation of damped harmonic oscillator and its solution, Discussion of different cases. Logarithmic decrement Energy equation of damped oscillations	**8**
II	**Forced Oscillations:** Differential equation of forced oscillations and its solution (transient and steady state). Amplitude and phase of forced oscillations Resonance and its examples: mechanical (Barton's pendulum), optical (sodium vapour lamp) Velocity and Amplitude resonance Sharpness of resonance Energy equation of forced oscillations Equation of coupled oscillations	**8**
III	**Wave Motion:** Differential equations of wave motion in continuous media Equations for longitudinal wave and its solution (one dimension only) Equation for transverse wave and its solution (one dimension only) Energy density and intensity of a wave Discussion of seismic waves	**6**
IV	**Doppler effect and Sound:** **Doppler effect** Explanation of Doppler effect in sound Expression for apparent frequency in different cases Asymmetric nature of Doppler effect in sound Doppler effect in light. Symmetric nature of Doppler effect in light.	**8**

	Applications: Red and Blue shift, Radar **Sound** Definition of sound intensity, loudness, pitch, quality(timber) Reverberation time and Reverberation of a hall Sabine's formula (without derivation) Stroboscope	
V	**Interference:** Basic theory of interference, Phase change on reflection (Stoke's treatment), Interference due to thin film: Uniform thickness film, Wedge shaped film, Newton's ring (Construction and Applications), Michelson interferometer (Principle and Construction), Applications of Michelson Interferometer (Determination of thickness of transparent media, Resolution of spectral lines), AR coating and Dielectric mirror	**10**
VI	**Diffraction:** Types of diffraction: Fraunhoffer diffraction and Fresnel's diffraction Fraunhoffer diffraction at: single slit, double slit, N slit, circular aperture Fresnel diffraction: Huygen's Fresnel theory, Fresnel's assumption, Fresnel's half period zone, Zone plate Resolving Power: Rayleigh criterion for resolution, Resolving power of telescope and transmission grating	**13**
VII	**Polarization:** Polarized and unpolarized light, types of polarization: plane, circularly and elliptically polarized light, Malus law, double refraction, retarders (QWP and HWP), generation and analysis of circularly and elliptically polarized light. Applications of polarized light (sunglasses, photography, LCDs).	**07**

References:

1. The Physics of Waves and Oscillations, N. K. Bajaj, Tata McGraw- Hill, Publishing co. Ltd.
2. A textbook of sound, Subramanyam and Brijlal, Vikas Prakashan
3. Waves and Oscillations, R. N. Chaudhari, New age international (P) ltd.
4. Fundamentals of vibration and waves, S P Puri, Tata McGraw-Hill Publishing co. ltd.
5. A Textbook of Optics, N. Subhramanyam, Brijlal, M. N. Avadhanulu, S. Chand publication.
6. Undergraduate physics Vol II, A. B. Bhattacharya and R. Bhattacharya, New central book agency (P) Ltd.
7. Optics, A. K. Ghatak, McMillan, New Delhi.
8. Optics, fourth edition, Pearson education, E. Hetch, A. R. Ganesan.
9. Fundamentals of Optics, F. A. Jenkins, H. E. White, McGraw- Hill international Edition.

S. Y. B. Sc. Semester III		
PHY-211	**Oscillations and Optics**	**Credits: 02 Hours: 30**
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO1	Identify various physical phenomena and parameters related to oscillations and optics.	1
CO2	Illustrate the fundamental concepts of oscillations and optics.	2
CO3	Apply the concepts of oscillations and optics to different numerical problems.	3
CO4	Explain the outcomes of real-world problems.	4
CO5	Justify the quantitative problem-solving skills in all the topics covered.	5
CO6	Develop an intuition towards problems solving and design realistic applications in the physical world.	6

Unit. No.	Title of Unit and Contents	No. of Lectures
I	**Undamped and Damped Oscillations** **Undamped Oscillations** Differential equation of S.H.M. and its solution (exponential form) Composition of two perpendicular linear S.H.M. s in frequency ratio 1:1 and 1:2 (analytical method) Compound Pendulum, Bar Pendulum, Kater's Pendulum. **Damped oscillation** Differential equation of damped harmonic oscillator and its solution, Discussion of different cases. Logarithmic decrement, Energy equation of damped oscillations	**7**
II	**Forced Oscillations** Differential equation of forced oscillations and its solution (transient and steady state). Amplitude and phase of forced oscillations Resonance and its examples: mechanical (Barton's pendulum), Velocity and Amplitude resonance Sharpness of resonance Introduction to wave motion, types of waves, longitudinal and transverse waves **Doppler effect:** Explanation of Doppler effect in sound Expression for apparent frequency in different cases.	**8**
III	**Interference and diffraction:** Interference: Basic theory of interference, Phase change on reflection (Stoke's treatment), Interference due to thin film: Uniform thickness film, Wedge shaped film, Newton's ring (Construction and Applications), Michelson interferometer (Principle and Construction) Diffraction: Types of diffraction, diffraction at single slit and grating	**10**
IV	**Polarization:** Polarized and unpolarized light, types of polarization: plane, circularly and elliptically polarized light, Malus law, double refraction, Applications of polarized light (sunglasses, photography, LCDs).	**5**

References:

1. The Physics of Waves and Oscillations, N. K. Bajaj, Tata McGraw- Hill, Publishing co. Ltd.
2. A textbook of sound, Subramanyam and Brijlal, Vikas Prakashan.
3. Waves and Oscillations, R. N. Chaudhari, New age international (P) ltd.
4. Fundamentals of vibration and waves, S P Puri, Tata McGraw-Hill Publishing co. ltd.
5. Oscillations and Waves Satya Prakash, Pragati Prakashan.
6. A Textbook of Optics, N. Subhramanyam, Brijlal, M. N. Avadhanulu, S. Chand publication.
7. Undergraduate physics Vol II, A. B. Bhattacharya and R. Bhattacharya, New central book agency (P) Ltd.
8. Optics, A. K. Ghatak, McMillan, New Delhi.

S. Y. B. Sc. Semester III		
PHY-212	**Physics Practical - 3**	**Credits: 2 Hours: 60**
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO1	Recall basic principles of oscillation, waves and optics.	1
CO2	Arrange experimental setup and interpret experimental data on pendulum systems.	2
CO3	Evaluate gravitational acceleration ('g') through different methods.	3
CO4	Apply optical principles in experimental setups.	4
CO5	Utilize diffraction patterns for measurements.	5
CO6	Perform experiments using given procedures, specifying outcomes, and integrating the measuring instrumentation system.	6

Expt. No.	Title of the Experiment
1.	Log decrement of the oscillator in air and water
2.	Determination of coupling coefficient of coupled pendulum
3.	Verification of frequency relations using a coupled pendulum
4.	'g' by Simple Pendulum
5.	'g' by Bar Pendulum
6.	Determination of the radius of curvature of a lens using Newton's rings
7.	Determination of wavelength of light using diffraction grating
8.	Kater's pendulum
9.	Determination of velocity of sound in air using resonance tube
10.	'Y' by vibration of wooden bar
11.	Study of Double refraction using prism
12.	Demonstration Experiment I
13.	Demonstration Experiment II
Any 10 experiments: 8 Experiments + 2 Demonstrations need to be performed	

S. Y. B. Sc. Semester III		
PHY-220	**निसर्गातील नॅनोरचना: विज्ञान आणि तंत्रज्ञान**	**Credits: 2 Hours: 30**
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO1	नॅनोविज्ञानाचे मौलिक सिद्धांत स्पष्टपणे व्याख्या करणे.	1
CO2	प्राकृतिक नॅनोसंरचनांचे उदाहरण देणे.	2
CO3	आयुर्वेदात नॅनो कणांचे वापर आणि दमास्कस स्वर्णाचा कामगारपणा ह्याचा विश्लेषण करा, प्राचीन मानवांच्या नॅनो सामग्रींचा वापर समजून घ्या.	3
CO4	फुलरिन्स, कार्बन नॅनोट्यूब्स अशा मानवनिर्मित नॅनो सामग्रींचा विश्लेषण करा.	4
CO5	नॅनोसामग्रींची तयारीसाठी टॉप-डाउन आणि बॉटम-अप पद्धतींचा वापर करून त्याबद्दल चर्चा करा.	5
CO6	प्राकृतिकपणे नॅनोसंरचनांचे संग्रह करा आणि त्याबद्दल एक अहवाल लिहा.	6

Unit. No.	Title of Unit and Contents	No. of Lectures
1	**प्रस्तावना :-** - नॅनो म्हणजे काय ? किती सूक्ष्म ? - नॅनोविज्ञानआणि नॅनोतंत्रज्ञान म्हणजे काय ? - नॅनोशिक्षण	**4**
2	**निसर्गातील नॅनोरचना** -कमळ, फुलपाखरे ,मोरपीस, पाल, पाननिवाळा, डास , वाळवंटातील किडे, धीवर पक्षी, रंगीत मासे, समुद्र उंदीर, जीवाणू	**6**
3	**प्राचीन युगातील नॅनो** -आयुर्वेदआणि नॅनोकण -दमास्कस तलवार -शोभिवंत खिडक्या	**4**
4	**मानवनिर्मितनॅनो** शुन्यमिती, एकमिती, द्विमिती, त्रिमितीय नॅनोपदार्थ नॅनो पदार्थांचे गुण धर्म -फुलरीन -कार्बन नॅनोनळ्या -एरोजेल -नॅनोकण - चांदी, सोने	**6**
5	**नॅनोपदार्थ तयार करण्याच्या पध्दती** १) टॉप डाऊन २) बॉटमअप 3) सूक्ष्मदर्शकयंत्रे	**4**
6	**दैनंदिन जीवनातील नॅनो :** घरगुती उपकरणे, स्वनिर्मळकाचा, दळणवळण, प्रदूषण, संगणक, इलेक्ट्रॉनिक्सआणि इलेक्ट्रिकल, उपकरणे, खेळणी, वस्त्रउद्योग, वैद्यकशास्त्रआणि कृषी, औषध निर्माण, सौंदर्य प्रसाधने, विमान तंत्रज्ञान, संरक्षण	**6**

संदर्भ:

1. नॅनोटेक्नॉलॉजीची मूलभूत तत्त्वे, सीआर सी प्रेस, जी.एल. हॉर्नयाक, जे. जे. मून, एच.एफ. तिहाळे, जे. दत्ता
2. मूलभूत नॅनो सायन्स:सुलभा कुलकर्णी

S. Y. B. Sc. Semester III		
PHY-220	**Introduction to Nanoscience**	**Credits: 2 Hours: 30**
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO1	Define fundamental principles of nanoscience.	1
CO2	Give examples of nanostructures in nature.	2
CO3	Interpret the uses of nano particles in Ayurveda and the crafting of Damascus swords, gaining insights into early human utilization of nano materials.	3
CO4	Analyze man-made nano materials like fullerenes, carbon nanotubes.	4
CO5	Argue about top-down and bottom-up methods for nanomaterial preparation.	5
CO6	Collect nanostructures from the nature and write a report on it.	6

Unit. No.	Title of Unit and Contents	No. of Lectures
1	**Preface:** What is Nano? How subtle? What is Nanoscience and Nanotechnology? Nano education	**4**
2	**Nanostructures in nature** - Lotus, butterflies, moths, sails, leafhoppers, mosquitoes, desert insects, waterfowl, colourful fish, sea rats, Bacteria	**6**
3	**Nano in ancient times** -Ayurveda and Nano particles -Damascus sword -Elegant windows	**4**
4	**Man-made Nano Materials One Dimensional, One Dimensional, Two Dimensional, Three Dimensional** Nano Materials Properties of Nano Materials -Fullerene -Carbon Nano tubes -Aerogel -Nanoparticles - silver, gold	**6**
5	**Methods of preparation of nanomaterials** Microscopes 1) Top down 2) Bottom up 3) Electron Microscopy	**4**
6	**Nano in everyday life** Household appliances, Self-cleaning glass , Communication pollution Computers, Electronics and Electrical, Appliances, Toys, Textile industry, Medicine and Agriculture, Drug Manufacturing, Cosmetics, Aircraft technology, Defence	**6**

References:

1. Fundamentals of Nanotechnology, CRC press, by G. L. Hornyak, J. J. Moone, H. F. Tihhale, J. Dutta
2. Fundamental of Nanoscience by Sulbha Kulkarni

S. Y. B. Sc. Semester III		
PHY-230	**Electrical circuit and network skills**	**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 electronic components.	1
CO2	Interpret the function of various electronic components and solid-state devices.	2
CO3	Apply knowledge of multimeters to determine different parameters of electronic components	3
CO4	Explain the working of simple electronic circuits constructed by using electronic components.	4

Unit. No.	Title of Unit and Contents	No. of Lectures
I	**Fundamentals of Electronics** Introduction to Electronics, circuit symbols. Electronic Components: Resistors, Capacitors, Inductors, Relays, Batteries, Switches, Diodes, LDR, LED, Photodiode, Thermistors. Series and parallel combination of resistors, capacitors and inductors.	**8**
II	**Network Theorems and its Applications** Kirchoff's Voltage Law and Kirchoff's Current Law, Thevenin, Norton, superposition and maximum power transfer theorems and Applications. Voltage and Current Sources: Variable and constant voltage and current sources	**10**
III	**Diode and Transistors:** **Diodes:** Construction and working, Types of diodes Biasing, I/V Characteristics, Diode as switch and rectifier. **Transistors:** Construction and working, Types of Transistors, Biasing: CB, CC, CE, I/V Characteristics, Transistor as switch. Power Transistor 3055, Transistor as amplifier	**8**
IV	**Simple Electronic Circuits** Multimeter Circuit LED Circuit with potentiometer Simple Temperature Monitor using transistors and diodes, Simple LDR Circuit	**4**

References

1. Basic Electronics: Solid State by B. L. Thareja (Publication S Chand and Company Ltd)
2. Principles of Electronics by V. K. Mehta (Publication S Chand)
3. Basic Electronics Devices, Circuits and It Fundamentals by Santiram Kal (Publication PHI)

S. Y. B. Sc. Semester III		
PHY-240	**Renewable Energy and Energy Harvesting**	**Credits: 2 Hours: 30**
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO1	Identify and differentiate various types of energy sources.	1
CO2	Interpret different types of non-conventional energy.	2
CO3	Classify various renewable energy sources and specify different energy harvesting systems.	3
CO4	Explain various type of Energy harvesting processes and determine various parameters in terms of renewable energy.	4

Unit. No.	Title of Unit and Contents	No. of Lectures
I	**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 in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity. **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. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems.	**9**
II	**Wind Energy harvesting**: Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies. **Ocean Energy**: Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices. Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass. **GeothermalEnergy**: Geothermal Resources,Geothermal Technologies. **Hydro Energy**: Hydropower resources, hydropower technologies, environmental impact of hydro power sources.	**12**
III	**Piezoelectric Energy harvesting**: Introduction, Physics and characteristics of piezoelectric effect, materials and mathematical description of piezoelectricity, Piezoelectric parameters and modeling piezoelectric generators, Piezoelectric Energy harvesting applications, Human power. **Electromagnetic Energy Harvesting:** Linear generators, physics mathematical models and applications. Carbon captured technologies, cell, batteries, power consumption Environmental issues and Renewable sources of energy, sustainability.	**09**
	Demonstrations and Experiments 1. Demonstration of Training modules on Solar energy, wind energy. 2. Conversion of thermal energy into voltage using thermoelectric modules. 3. Conversion of mechanical into electrical energy	

References

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 Sukhatme Tata McGraw - Hill Publishing Company Ltd.
4. Godfrey Boyle, "Renewable Energy, Power for a sustainable future", 2004, Oxford University Press, in association with The Open University.
5. Dr. P Jayakumar, Solar Energy: Resource Assessment Handbook, 2009
6. J. Balfour, M. Shaw and S. Jarosek, Photovoltaics, Lawrence J Goodrich (USA).
7. http://en.wikipedia.org/wiki/Renewable_energy

S. Y. B. Sc. Semester III		
VPH-230	**Basics of Photography**	**Credits: 02 Hours: 30**
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive levels**
CO1	Identify the photographic process.	1
CO2	Explain the fundamentals of the photographic process.	2
CO3	Use the photographic equipment for a given situation.	3
CO4	Relate the role of light in a photographic process.	4
CO5	Justify the use of photographic equipment for a given photographic assignment.	5

Unit. No.	Title of Unit and Contents	No. of Lectures
1	**What is Photography?** - Meaning of Photography. - Photography as a Medium **Formation of a Digital Image** - Digital image (Pixel) - Technical Qualities of a Photograph	**9**
2	**History of Photography in Short** - Pinhole camera - Box Camera - Parallax error (and its removal) - Need for the Invention of a SLR	**4**
3	**DSLR (Handling techniques)** - Knowing the equipment and its functionality - What is an Exposure - Functions and effects of Aperture, Shutter, ISO - equivalent exposures - setting a White Balance for the images	**7**
4	**Aesthetics of images** - Aesthetic qualities of an image - Composition rules and design principles **Formats and Lenses** - Camera Formats - Types of lenses (Wide / Normal / Tele) - What is Perspective?	**10**

References:

1. Langford's Advanced Photography - the Guide for aspiring Photographers
2. The camera by Ansel Adams
3. Basic Photography, M. J. Langford, Focal Press
4. Focal encyclopaedia of Photography, Focal Press
5. A large number of photography related sites are available on the internet.
   https://www.youtube.com/@PIXELVIILAGE
   https://www.youtube.com/@theartofphotography

SEMESTER IV

S. Y. B. Sc. Semester IV		
PHY-250	**Physics Practical - 4**	**Credits: 2 Hours: 60**
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO1	Recall the principles of charging and discharging capacitors in series and parallel circuits.	1
CO2	Interpret vector diagrams to illustrate phase relationships between voltage and current in LR circuits.	2
CO3	Investigate resonance conditions in circuits and their effects on performance.	3
CO4	Analyze circuits using different theorems to solve diverse electrical problems.	4
CO5	Validate practical experiments with diodes in different configurations.	5
CO6	Assemble and utilize a magnetometer to determine pole strength in practical exercises.	6

Expt. No.	Title of the Experiment
1.	Charging and discharging of capacitors (series and parallel combination)
2.	Study of series LR circuit and vector diagram
3.	Study of LCR series resonance circuit
4.	Verification of circuit theorems
5.	Diode characteristics
6.	Determination of pole strength using a magnetometer
7.	Zener Stabilized Power Supply
8.	Determination of BH by tangent galvanometer
9.	Determination of the dielectric constant of a given sample
10.	Study of half wave and full wave rectifier
11.	Study visit
Any 10 experiments: 8 Experiments + Study Visit (equivalent to two experiments) need to be performed	

S. Y. B. Sc. Semester IV		
PHY-251	**Electricity and Magnetism**	**Credits: 4 Hours:60**
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO1	Identify various physical parameters related to electricity and magnetism.	1
CO2	Illustrate the mathematical treatment of concepts of electricity and magnetism. Interpret fundamental laws of electricity and magnetism. Differentiate the vector and scalar field in the formalisms of electrostatics and magnetostatics.	2
CO3	Apply the concepts of electricity and magnetism to different numerical problems.	3
CO4	Explain the outcomes of real-world problems.	4
CO5	Validation of system by using phenomena of electricity and magnetism.	5
CO6	Demonstrate concepts of electricity and magnetism through models and experiments.	6

Unit. No.	Title of Unit and Contents	No. of Lectures
1	**Vector Analysis:** Review of vector algebra (Scalar and Vector product), gradient, divergence, Curl and their significance, Vector Integration, Line, surface and volume integrals of Vector fields, Gauss-divergence theorem and Stoke's theorem of vectors (statement only).	**9**
2	**Electric Field and Electric Potential:** Electric field: Electric field lines. Electric flux. Gauss' Law (integral and differential form) with applications to charge distributions with spherical, cylindrical and planar symmetry. Conservative nature of Electrostatic Field. Electrostatic Potential. Potential and Electric Field of a dipole. Force and Torque on a dipole.	**12**
3	**Electric Field, Potential and Energy:** Electrostatic energy of system of charges. Electrostatic energy of a charged sphere. Conductors in an electrostatic Field. Surface charge and force on a conductor. Capacitance of a system of charged conductors. Parallel-plate capacitor. Capacitance of an isolated conductor. The Uniqueness Theorem. Method of Images and its application to: (1) Plane Infinite Sheet and (2) Sphere.	**10**
4	**Dielectric Properties of Matter:** Electric Field in matter. Polarization, Polarization Charges. Electrical Susceptibility and Dielectric Constant. Capacitor (parallel plate, spherical, cylindrical) filled with dielectric. Displacement vector **D**. Relations between **E**, **P** and **D**. Gauss' Law in dielectrics.	**8**
5	**Magnetic Field:** Magnetic force between current elements and definition of Magnetic Field **B**. Biot-Savart's Law and its simple applications: straight wire and circular loop. Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole). Ampere's Circuital Law and its application to (1) Solenoid and (2) Toroid. Properties of **B**: curl and divergence. Vector Potential. Magnetic Force on (1) point charge (2) current carrying wire (3) between current elements. Torque on a current loop in a uniform	**9**

	Magnetic Field.	
6	**Magnetic Properties of Matter:** Magnetization vector (**M).** Magnetic Intensity (**H).** Magnetic Susceptibility and permeability. Relation between **B, H, M**. Brief introduction of dia-, para-and ferro- magnetic materials. Ferromagnetism. B-H curve and hysteresis.	**5**
7	**Electrical Circuits:** AC Circuits: Kirchhoff's laws for AC circuits. Complex Reactance and Impedance. Series LCR Circuit: (1) Resonance, (2) Power Dissipation and (3) Quality Factor, and (4) Band Width.	**07**

References:

1. Introduction to Electrodynamics, D. J. Griffiths, 3rd Edn., 1998, Benjamin Cummings.
2. Concept of Physics by H. C. Verma Part – II.
3. Electricity and Magnetism, Satya Prakash, Pragati Prakashan.
4. Electricity, Magnetism & Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw Hill.
5. Feynman Lectures Vol. 2, R. P. Feynman, R. B. Leighton, M. Sands, 2008, Pearson Education.

S. Y. B. Sc. Semester IV		
PHY-261	**Basics of Electricity and Magnetism**	**Credits: 2 Hours: 30**
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO1	Recall the concepts associated electrostatics and magnetism	1
CO2	Discuss the atomic view of polarization of matter. Explain the correlation in electricity and magnetism.	2
CO3	Compute the boundary conditions and calculate quantities like current, voltage, power, phase, impedance, etc in DC and AC circuits.	3
CO4	Classify the phase relations in AC circuits.	4
CO5	Compare the growth and decay of current in DC circuits.	5
CO6	Write the phase relations between different parameters (like current, voltage, power and impedance) in simple electronic circuits comprising of resistors, inductors and capacitors.	6

Unit. No.	Title of Unit and Contents	No. of Lectures
I	**Electric field:** Electric charge, Quantization of charge, frictional electricity (real world examples), electrostatic force and Coulomb's law, simple problems on Coulomb's law. Electric field due to point charge. Superposition principle, electric flux, Gauss's lawand simple applications, electric potential.	10
II	**Dielectric properties of Matter:** Electric dipole, torque on dipole, Polar and nonpolar molecules, Dielectrics, Polarization in dielectric, dielectric constant and dielectric breakdown, susceptibility, permittivity, capacitor with and without dielectrics, charging and discharging of capacitor.	6
III	**Magnetism:** Lorentz force, cyclotron frequency, Biot-Savart law and applications (line current), Ampere's circuital law, Solenoid Magnetic material and their types	10
IV	**A C circuits:** Phasors, Resistance and Reactance, pure resistive, inductive and capacitive circuit, LR circuit, L-R-C series circuit, Resonance in AC circuit.	10

References:

1. Concept of Physics by H. C. Verma Part – II.
2. Electricity and Magnetism, Satya Prakash, Pragati Prakashan.
2. Sears and Zemansky's University Physics, 12th Edition, H. D. Young, R. A. Freedman, A. L. Ford, F. W. Sears, Pearson Education.
3. Fundamentals of electricity and Magnetism, Arthur Kip, McGraw-Hill.

S. Y. B. Sc. Semester IV		
PHY-262	**Physics Practical - 4**	**Credits: 2 Hours: 60**
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO1	Recall and understand the fundamental principles of capacitor charging and discharging.	1
CO2	Explain the relationship between resistance and inductance in series LR circuits.	2
CO3	Apply resonance concepts to optimize LCR series resonance circuits.	3
CO4	Analyze and verify Kirchhoff's Laws in various circuit configurations.	4
CO5	Evaluate diode behavior through graphical representation and data analysis.	5
CO6	Design and calculate the ripple factor and efficiency of a half-wave rectifier.	6

Expt. No.	Title of the Experiment
1.	Charging and discharging of a capacitor
2.	Study of series LR circuit and vector diagram
3.	Study of LCR series resonance circuit
4.	Verification of Kirchhoff's laws
5.	Diode characteristics
6.	Determination of pole strength using a magnetometer
7.	Zener Stabilized Power Supply
8.	Determination of B_H by tangent galvanometer
9.	Determination of the dielectric constant of a given sample
10.	Determination of ripple factor and efficiency of half wave rectifier
11.	Study visit
Any 10 experiments: 8 Experiments + Study Visit (equivalent to two experiments) need to be performed	

S. Y. B. Sc. Semester IV		
PHY-270	**Meteorology**	**Credits: 2 Hours: 30**
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO1	Identify and understand the constituents of the atmosphere.	1
CO2	Interpret and compare atmospheric parameters like temperature, pressure, humidity, solar radiation, precipitation, wind and familiarize with measurement of these parameters.	2
CO3	Relate the effects of global warming and climate change.	3
CO4	Correlate and illustrate the effect of green gases in global warming and understand the measures to reduce these effects. Importance of ozone layer.	4

Unit. No.	Title of Unit and Contents	No. of Lectures
I	General Meteorology: Atmosphere and Atmospheric effect, Meaning and scope of Meteorology, The planetary atmospheres, Equilibrium temperatures, Composition of atmosphere, Variation of composition with respect to i) Altitude, ii) Latitude iii) Time. Vertical structure of Earth's atmosphere.	**10**
II	Nature of radiations & Properties, Effects of atmosphere: Scattering, Reflection & Absorption of solar radiations, Effects of Scattering, Terrestrial radiation, Greenhouse effect. Ozone formation photochemical processes, Absorption of solar radiation by Ozone, Depletion of Ozone layer & Ozone hole, Ozone in Troposphere.	**10**
III	Climatology: Introduction, Nature, Scope, Content of Climatology. Climatology and meteorology. Global circulation of the atmosphere, air mass, atmospheric disturbances, seasonal disturbances.	**5**
IV	Meteorological Instruments: Measurements of Rain, Temperature, pressure, wind, humidity, radiation. Tephigram and its interpretation.	**5**

References:

1. General Meteorology H. R. Byers
2. Meteorology William L. Dorn
3. Climatology Lal D.S.
4. Climatology and atmospheric science J.E. Oliver & J. J. Hidore
5. Introduction to Meteorology Pellersons
6. Elementary Meteorology, William Morris Davis
7. Essentials of Meteorology D.H. Mclntosh & A.S. Thom
8. Meteorology D. Brun
9. Fundamentals of Meteorology, by Prasad Bapat (Author), Vinayak Hiremath (Author)

S. Y. B. Sc. Semester IV		
PHY-280	**Python**	**Credits: 2 Hours: 30**
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO1	Introduce the Python environment to enhance computational skills.	1
CO2	Get exposure to arithmetic, assignment, relational, logical, and Boolean operators.	2
CO3	Understand variables, input, and output functions in python.	3
CO4	Use Libraries for various computation.	4
CO5	Determine the methods to create and manipulate Python programs by utilizing the data structures like lists, dictionaries, tuples and sets.	5

Unit. No.	Title of Unit and Contents	No. of Lectures
1	**Introduction to Python** Python Introduction, History of Python, Introduction to Python Interpreter and program execution, Python Installation Process in Windows and Linux, python variable declaration, Keywords, Indents in Python, Python input/output operations	**3**
2	**Python's Operators** Arithmetic Operators, Comparison Operators, Assignment Operators, Logical Operators, Bitwise Operators, Membership Operators, Identity Operators, Ternary Operator, Operator precedence.	**4**
3	**Python's Built-in Data types** String, List, Tuple, Set, Dictionary (characteristics and methods)	**5**
4	**Conditional Statements & Loop** Conditional Statements (If, If-else, If-elif-else, Nested-if etc.) and loop control statements (for, while, Nested loops, Break, Continue, Pass statements)	**5**
5	**Function in Python** Introduction to functions, Function definition and calling, Function parameters, Default argument function, Variable argument function, in built functions in python, Scope of variable in python	**5**
6	**File Processing** Concept of Files, File opening in various modes and closing of a file, Reading from a file	**5**
7	**Modules and Classes** Concept of modularization, Importance of modules in python, importing modules, Built in modules (ex: NumPy, SciPy, Matplotlib), python classes	**3**

References:

1. Python Programming: Using Problem Solving Approach by Reema Thareja.
2. Think Python by Allen Downey.
3. Problem Solving and Python Programming by Bal Guruswami McGraw Hill.
4. Learning with Python by Allen Downey.

S. Y. B. Sc. Semester IV		
PHY-290	**Solar PV Systems**	**Credits: 2 Hours: 30**
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO1	Describe key solar electricsystem terms and concepts.	1
CO2	Understand a photovoltaic system.	2
CO3	Mount, ground, position, install, wire and connect a photovoltaic system.	3
CO4	Analyze voltage generated by photovoltaic system, operate and maintain the solar power.	4
CO5	Understand and evaluate different types of solar PV module and batteries used in solar PV plant.	5
CO6	Design of solar PV Plant based on estimated loads.	6

Unit. No.	Title of Unit and Contents	No. of Lectures
I	**Solar Scenario and Available Technologies** Overview of Global Scenario in renewable Energy, national action plan on climate change, Jawaharlal Nehru national solar mission, state wise initiatives, policy framework support in India for RE, Exemption from Taxes, Current Status of SPV Industry, Renewable Purchase Obligation, present status in various States, Future possibilities due to RPO, Solar Energy- Principles & Technology, Concepts of Solar PV, Introduction to Solar Energy, Irradiance, Solar Window & tilt angle, Atmospheric effects,Diffused radiation, Solar air mass, the sensitivity of PV materials to various wavelengths, Cell efficiency and fill factor, Response to temperature, irradiation, Materials used for Solar PV, Latest development of technologies in Solar PV, future trends in solar cell technology, Instruction to components of a solar photovoltaics system: modules, array, inverters, balance-of-system components, safety devices etc.	**12**
II	**Case Study of Grid-Connected Systems** Case study of a 2 MW SPV Plant –Student to design complete plant with assessment of energy generation on software and prepare Auto Cad drawings.	**8**
III	**Photovoltaic System Operation and Maintenance** System maintenance, PV array maintenance, Inverter maintenance, System integrity, Troubleshooting, identifying the problem, Troubleshooting PV arrays, Troubleshooting underperforming systems, Troubleshooting inverters, and Other common problems.	**10**
IV	**Experiments (6 experiments)** 1. Performance of SPV module: a. Current-voltage characteristic curve (I-V Curve) construction b. Physical properties of solar module and temperature dependence c. I-V and P-V characteristics with series and parallel combination of modules 2. Effect of direct and diffuse radiation on crystalline and thin film modules (by using a sun meter) 3. Assemble and dismantle of solar lanterns	

	4. Solar water pump system (Day (water pump) + Night (Home lighting)) 5. Understanding of various parts of the inverter (non-working) 6. Tools and accessories used in solar PV systems and power plants	

References:

1. Roger A Messenger and Jerry Ventre, "Photovoltaic Systems Engineering" Second Edition, CRC Press, Taylor & Francis Group, 2004.
2. Antonio Luque, Steven Hegedus, "Handbook of Photovoltaic Science and Engineering" John Wiley & Sons, 2011.
3. Stuart R. Wenham, "Applied Photovoltaics", Earthscan, 2007.
4. Falk Antony, Christian Dürschner, Karl-Heinz Remmers, "Photovoltaics for professionals: solar electric systems marketing, design and installation", Earthscan Solarpraxis AG, 2007.
5. Mary D. Archer, Robert Hill, "Clean Electricity from Photovoltaics", Imperial College Press, 2001
6. Chetan Singh Solanki, "Solar photovoltaics: fundamentals, technologies and applications" 2nd edition, PHI Learning New Delhi, 2011.

S. Y. B. Sc. Semester IV		
VPH-280	**Image Processing & Graphic Design**	**Credits: 02 Hours: 30**
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive levels**
CO1	Identify the need for image processing.	1
CO2	Explain the use of different tools of image processing software.	2
CO3	Use the image processing software for a given situation.	3
CO4	Relate the role of light and colour in image processing.	4
CO5	Justify the use of image processing software.	5

Unit. No.	Title of Unit and Contents	No. of Lectures
1	**What is Image Processing** Introduction to Software **Adobe Lightroom** Introduction to Lightroom Benefits of Lightroom Making a Catalog Lightroom I Exposure Adjustment Tools Lightroom II - Tone Curve and Colour Grading Treatment - Masking (Brush, Linear, Radial) - Exporting	10
2	**Adobe Photoshop** Introduction to Photoshop Panel, Layers, Canvas Tools (Brush and Pen) **Adobe Camera RAW** Working with Camera RAW Files	8
3	**Exposure Treatment** Adjustment Layer Levels Curves **Understanding Blending Modes**	5
4	**Dodge & burn** Portrait retouching Exposure tuning Colour Correction **Black & White** Black and White treatment to Colour Zone System Contrast **Photo restoration**	8

References:

1. Evans, P. and Thomas, M. A. (2012). Exploring the elements of design. Cengage Learning.
2. https://www.youtube.com/@PiXimperfect
3. https://www.youtube.com/@Photoshop
4. https://www.youtube.com/watch?v=T0f0NiDBPbk