Bachelor of Science B.Sc.
Physics (Semester -V)

Course Code	US05MAPHY01	**Title of the Course**	Classical Mechanics
Total Credits of the Course	4	**Hours per Week**	4
Course Objectives:	1. To provide training of the generalized coordinates to deal with mechanics of classical systems through Lagrangian formulation. 2. To create awareness about rotating co-ordinate systems and its application to study the motion of Earth, rigid body motions, motion of symmetric top etc. 3. To provide an exposure to the mathematical techniques of calculus of variation and its applications to physical systems through Lagrangian and Hamiltonian method.		

Course Content		
Unit	**Description**	**Weightage (%)**
1.	**Lagrangian Formulation** Constraints, Generalized co-ordinates, D'Alembert's principle, Lagrange's equations, A General expression for kinetic energy, Symmetries and the laws of conservation, Cyclic or Ignorable coordinates, Illustrations, Velocity dependent potential of electromagnetic field, Rayleigh's dissipation function. [Introduction to Classical Mechanics by R G Takwale & P S Puranik : 8.1, 8.2, 8.3, 8.4, 8.5, 8.6, 8.7, 8.8, 8.9]	25%
2.	**Moving coordinate systems and motion of a rigid body** Coordinate systems with relative translation motions, Rotating coordinate systems, The Coriolis force, Motion on the earth, Effect of Coriolis force on freely falling particle, Euler's Theorem, Angular momentum and kinetic energy, The inertia tensor, Euler's equations of motion, Torque free motion, Euler's angles, Motion of a symmetric top. [Introduction to Classical Mechanics by R G Takwale & P S Puranik: 9.1, 9.2, 9.3, 9.4, 9.5, 10.1, 10.2, 10.4, 10.5, 10.6, 10.7]	25%
3.	**Variational Principle** Configuration space, Some techniques of calculus of variation, The δ Notations, Applications of the variational principle, Hamilton's principle, Equivalence of Lagrange's and Newton's equations, Advantages of the Lagrangian Formulation–Electro–Mechanical analogies, Lagrange's undetermined multipliers, Lagrange's equations for Non holonomic systems, Applications of the Lagrangian method of undetermined multipliers. [Introduction to Classical Mechanics by R G Takwale & P S Puranik: 11.1, 11.2, 11.3, 11.4, 11.5, 11.6, 11.7, 11.8, 11.9]	25%

4.	**Hamiltonian Formulation** Hamilton's equations of motion, Some applications of the Hamiltonian formulation, Phase Space, Comments on the Hamiltonian formulation, Gauge Transformation, Canonical transformation, Conditions for transformation to be Canonical, Illustrations of Canonical transformations, Poisson brackets. [Introduction to Classical Mechanics by R G Takwale & P S Puranik : 11.10, 11.11, 11.12, 11.13, 12.1, 12.2, 12.3, 12.4, 12.5]	25%

Teaching-Learning Methodology	Direct Teaching through Chalk-Walk and Talk ICT enabled teaching Question-Answer Class discussion led by teacher/students Case Studies Literature review Problem solving activities Debate Collaborative and Co-operative Learning Think Pair Share Jigsaw Inquiry Based Learning Panel Discussion Project Based Learning Flipped Classroom Blended Learning designs Concept Mapping

Evaluation Pattern

Sr. No.	Details of the Evaluation	Weightage
1.	Internal Continuous Assessment in the form of Internal Written Test, Quizzes, Assignments, Active learning, Viva-voce, Seminars, Attendance (As per NEP Guideline)	50%
2.	University Examination	50%

Course Outcomes: Having completed this course, the learner will be able to

1.	understand the generality of generalized coordinates and will be able to apply for the study of the mechanics of classical systems.
2.	understand the effect of rotational motion of the earth and its effect on weather conditions.

3.	They will get an idea of inertia and symmetry of rigid bodies, variational method for motion of the system as another formulation to solve mechanical problems.
4.	Students will be able to understand the production of Hamiltonian function and use of Lagrangian and Hamiltonian formulation for the study related to motion of classical systems.

Suggested References:

Sr. No.	**References**
1.	Introduction to Classical Mechanics R G Takwale and P S Puranik Tata McGraw Hill Education Pvt Ltd.
2.	Classical Mechanics Herbert Goldstein, Charles P. Poole and John Safko Third Edition, Pearson
3.	Classical Mechanics Aruldhas PHI Learning Pvt Ltd, New Delhi

On-line resources to be used if available as reference material

On-line Resources

https://www.google.com/search?q=Lagrangian+formulation&source=lnms&sa=X&ved=0ahUKEwiEjaPe1rHuAhVrFLcAHc2ZA18Q_AUICigA&biw=1094&bih=472&dpr=1.25

https://en.wikipedia.org/wiki/Hamiltonian_mechanics

https://bdigital.uvhm.edu.mx/wp-content/uploads/2020/06/variational-principles-classical-mechanics.pdf

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Bachelor of Science
B.Sc. Physics (Semester -V)

Course Code	US05MAPHY02	**Title of the Course**	Analog and Digital Circuits
Total Credits of the Course	04	**Hours per Week**	04
Course Objectives:	1. To train the students on the analog and digital electronic circuits and their applications in Voltage and power amplifications. 2. To provide exposure to the working and wide applications of operational amplifiers. 3. To train the students in the basics of digital logic circuits and the working and applications of digital circuits as registers, counters etc.		

Course Content		
Unit	**Description**	**Weightage (%)**
1.	**<u>Frequency Response of Amplifiers:</u>** **Low Frequency Response of The Transistor Amplifier:** Effect of Emitter Bypass Capacitor on Low Frequency response, Effect of Coupling Capacitor on Low Frequency response. **High Frequency Response of The Transistor Amplifier:** High Frequency Model For The Common Emitter Amplifier, Approximate CE High Frequency Model with a Resistive Load, CE Short Circuit Gain, High Frequency Current Gain with a Resistive Load. **Transistor Power Amplifiers:** Class A Direct Coupled Resistive Load, Transformer Coupled Resistive Load Amplifier. **Push-Pull Amplifiers:** Description of Operation of a Class A Push-Pull Amplifier, Theory of Operation of a Class A Push-Pull Amplifier. The Class B Push-Pull Amplifier, Crossover Distortion, Class AB Push-Pull Amplifier, Transistor Phase Inverter, Conversion Efficiency of a Class B Amplifier, Complementary Symmetry. [Electronic Devices and Circuits by Allen Mottershead: 15-1, 15-2, 16-1, 16-2, 16-3, 16-4, 19-1, 19-2, 19-11, 19-12, 19-13, 20-1, 20-2, 20-3, 20-4, 20-5, 20-10] Related Numerical	25%

2.	**Operational Amplifiers:** **Operational Amplifier Characteristics:** Basic Differential amplifier analysis, DC Analysis of the Bipolar Diff. Amplifier, AC Analysis of the Bipolar Diff. Amplifier, The Common mode rejection ratio – CMRR, The Ideal Operational Amplifier -Op-Amp., Inverting and Noninverting Amplifiers –Ideal case, Op-Amp Parameters –Definitions, Universal Balancing Techniques, Measurements of Op- Amp Parameters, General Description of various Stages in Op-Amp. **Applications of operational amplifier:** Summing amplifier (Inverting Mode) and Difference amplifier, The Integrator and Differentiator, Current to Voltage Converter, Voltage to Current Converter- Floating Load, Logarithmic Amplifier using diode (Basic only). [Integrated Circuits by K R Botkar : 7.1, 7.1.1, 7.1.2, 7.4.1, 7.4.2, 7.4.3, 7.4.4, 7.5.1, 8.3.1, 8.3.2, 8.4.2, 8.5.3] Related Numerical	25%
3.	**Number Systems, Gates and Logic Family:** **Number systems and codes:** Decimal and binary odometer, Binary numbers, Use of binary numbers, Binary to decimal conversion, Decimal to Binary conversion, Hexadecimal numbers, Hexadecimal Binary conversion, Hexadecimal to decimal conversion, Decimal to hexadecimal conversion, BCD numbers, The ASCII code. **Gates:** Inverters, OR gates, AND gates, Boolean algebra, NOR gates, De Morgan's first theorem, NAND gates, De Morgan's Second theorem, EXCLUSIVE-OR gates, EXCLUSIVE-NOR gates. **TTL circuits:** Digital integrated circuits, 7400 devices, TTL characteristics. [Digital Computer Electronics by P Malvino and J A Brown : 1-1, 1 2, 1-4, 1-5, 1-7, 1-8, 1-9, 1-10, 1-11, 1-12, 1-13, 2-1, 2-2, 2-3, 2-4, 3 1, 3-2, 3-3, 3-4, 3-5, 3-7, 4-1, 4-2, 4-3]] Related Numerical	25%

4.	**Flip-Flops, Registers and Counters:** **Flip –Flops:** Introduction, RS latches, Level clocking, D latches, Edge triggered D flip-flops, Edge triggered JK flip-flops, JK master slave flip flop. **Registers:** Buffer registers, Shift registers, Controlled shift registers. **Counters:** Ripple counters, Synchronous counters, Ring counters, MOD-10 counter, down counter. [Digital Computer Electronics by P Malvino and J A Brown: 7-1, 7 2, 7-3, 7-4, 7-5, 7-6, 8-1, 8-2, 8-3, 8-4, 8-5, 8-6, 8-7] Related Numerical	25%

Teaching-Learning Methodology	Direct Teaching through Chalk-Walk and Talk ICT enabled teaching Question-Answer Class discussion led by teacher/students Case Studies Literature review Problem solving activities Debate Collaborative and Co-operative Learning Think Pair Share Jigsaw Inquiry Based Learning Panel Discussion Project Based Learning Flipped Classroom Blended Learning designs Concept Mapping

Evaluation Pattern

Sr. No.	Details of the Evaluation	Weightage
1.	Internal Continuous Assessment in the form of Internal Written Test, Quizzes, Assignments, Active learning, Viva-voce, Seminars, Attendance (As per NEP Guideline)	50%
2.	University Examination	50%

Course Outcomes: On the successful completion of the course, the students will be able to	
1	Explain Transistor amplifiers and their analysis for different range of frequencies.
2	Describe the power capabilities of transistor power amplifiers and various techniques to achieve higher efficiency.
3	Understand the basic structure of Operational Amplifier and its analysis with its wide applications.
4	Analyse different number systems and different types of gates, flip-flops, registers and counters which are essential components of digital electronic technology.

Suggested References:

Sr. No.	**References**
1.	Allen Mottershead, Electronic Devices and Circuits, (2011), PHI Pvt. Ltd., New Delhi.
2.	K R Botkar, Integrated Circuits, Ninth Edition, (Fifth Reprint 2001), Khanna Publishers, New Delhi.
3.	P. Malvino and J. A. Brown, (Third Edition 2004), Digital Computer Electronics, Tata McGraw Hill Publishing Co. Ltd., New Delhi.
4.	G K Mittal, Electronic Devices and Circuits, (Twenty Third Edition), Khanna Publishers, New Delhi
5.	Jacob Millman and Christos C. Halkias, Integrated electronics: Analog and Digital Circuits and Systems, (2009) Tata McGraw Hill Pub. Co. Ltd, New Delhi
6.	P Malvino, Electronic Principles (Seventh Edition), Tata McGraw Hill Pub. Co. Ltd, New Delhi
7.	B L Theraja, Basic Electronics (Solid State), (Reprint 2007), S. Chand & Company Ltd.

On-line resources to be used if available as reference material
On-line Resources:
https://nptel.ac.in/courses/115/102/115102014/ https://nptel.ac.in/courses/115/102/115102014/ Online lectures of Power Amplifiers and Operational Amplifiers are available on YouTube also. https://nptel.ac.in/courses/108/105/108105132/ 12 weeks course with downloadable video lectures of Digital Electronic Circuits.
Glossary of Analog and Digital Circuits: Resource Type: Reference https://wiki.analog.com/university/courses/electronics/text/glossary This website contains a glossary of electronic terms used in analog electronics. It provides quick reference to the frequently used definitions. http://www.pmcgibbon.net/teachcte/electron/degloss1.htm This website provides quick reference to the terms used in digital electronics. The glossary can be browsed and searched, and contributions of new entries are welcome. **Analog and Digital Electronics: History** Resource Type: Other educational resources https://en.wikipedia.org/wiki/Analogue_electronics https://en.wikipedia.org/wiki/Digital_electronics https://www.elprocus.com/know-about-brief-history-of-electronics-and-their-generations/ A brief history and the development of electronics is provided. **Introduction to Electronic circuits**: Resource Type: Lecture notes https://www.ee.iitb.ac.in/~sequel/course_material.html Lecture notes slides, notes on selected topics, related lab sheets and Java application simulations are available for the ready reference. **Your source for the latest research news:** https://www.sciencedaily.com/news/matter_energy/electronics/

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Bachelor of Science
B.Sc. Physics Practical (Semester – V)

Course Code	US05MAPHY03	**Title of the Course**	Physics Practical
Total Credits of the Course	04	**Hours per Week**	08

Course Objectives:	1. To learn by performing experiments based on principles and applications of the theoretical courses. 2. To have working knowledge of equipment like CRO, Interferometer and electronic circuits. 3. To have the working knowledge of experiments related to optics, solid state physics, electrodynamics, analog and digital electronics etc. 4. To have ability to solve problems through numerical methods.

Course Content

Description	**Weightage (%)**
SECTION A: 1. Phage angle by C.R.O 2. Constants of ballistic galvanometer 3. Low resistance by ballistic galvanometer 4. Four probe method 5. Michelson interferometer (λ measurement) 6. Phonon dispersion relation of monoatomic chain 7. Hall effect (constant magnetic field)	50%
SECTION B: 1. Astable Multivibrator 2. Monostable Multivibrator 3. Operational amplifier (Inverting and non-inverting modes) 4. Frequency response of OpAmp 5. Logic gates (discrete and IC based AND, OR, NOT NAND and NOR gates) 6. Diagonalization of a matrix (Jacobi method) 7. Class A amplifier	50%

NOTE	Minimum 80% practical should be performed. To provide flexibility up to the maximum of 20% of total experiments can be replaced/ added to the list by respective colleges

Evaluation Pattern		
Sr. No.	**Details of the Evaluation**	**Weightage**
1.	Internal Continuous Assessment in the form of Internal Written Test, Quizzes, Assignments, Active learning, Viva-voce, Seminars, Attendance (As per NEP Guideline)	50%
2.	University Examination	50%

Course Outcomes: Having completed this course, the learner will be able to	
1.	various properties of materials like resistivity, low resistance, energy band gap, thickness of film, wavelength of monochromatic light etc.
2.	deduce numerical methods to analyze the observational data as well as the applications of numerical methods to solve dynamics of Physics problems.
3.	study various oscillatory circuits, transistor amplifiers, operational amplifiers and digital circuits.

Suggested References:	
Sr. No.	**References**
1.	Advanced Practical Physics for students B L Worsnop and H T Flint, Methuen and Co. Ltd., London
2.	B.Sc. Practical Physics C L Arora, S. Chand & Co. Ltd., New Delhi
3.	Advanced Practical Physics M S Chauhan and S P Singh, Pragati Prakashan, Meerut
4.	Advanced Practical Physics S L Gupta and V Kumar, Pragati Prakashan, Meerut
5.	An advanced course in practical Physics D Chattopadhyay and P C Rakshit, New Central book agency Pvt. Ltd

On-line resources to be used if available as reference material
On-line Resources
CONSTANTS OF BALLISTIC GALVANOMETER https://www.youtube.com/watch?v=Z5ZlYltXs9c http://www.stpius.ac.in/crm/assets/download/Practical_paper-2_-_Continued.pdf
LOW RESITANCE BY BALLISTIC GALVANOMETER http://www.stpius.ac.in/crm/assets/download/Practical_paper-2_-_Continued.pdf FOUR PROBE METHOD https://vlab.amrita.edu/?sub=1&brch=282&sim=1512&cnt=3 MICHELSON INTERFEROMETER https://vlab.amrita.edu/?sub=1&brch=189&sim=1106&cnt=1#:~:text=The%20Michelson%20interferometer%20is%20the,called%20an% https://www.youtube.com/watch?v=lzBKlY4f1XA DIAGONALIZATION OF MATRIX BY JACOBI METHOD https://www.youtube.com/watch?v=YfTrNElThDs https://www.patnauniversity.ac.in/e-content/science/physics/MScPhy58.pdf ASTABLE AND MONOSTABLE MULTIVIBRATORS https://www.electronics-tutorials.ws/sequential/seq_3.html INVERTING AND NON-INVERTING OPAMP https://www.electronics-tutorials.ws/opamp/opamp_2.html https://www.electronics-tutorials.ws/opamp/opamp_3.html FREQUENCY RESPONSE OF OPAMP https://www.allaboutcircuits.com/video-tutorials/op-amp-basics-frequency-response/

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Bachelor of science
B.Sc. Physics Semester-5

Course Code	US05MIPHY01	**Title of the Course**	Thermodynamics
Total Credits of the Course	2	**Hours per Week**	2

Course Objectives:	1. To provide the fundamentals of thermodynamics and their applications to study of thermal characteristics of different states of matter. 2. To provide the fundamental concept of Classical Statistical Mechanics. 3. To create awareness about the importance of partition functions and statistical distribution of particles for the better understanding of many body systems.

Course Content		
Unit	**Description**	**Weightage (%)**
1.	**Thermodynamical Laws and Entropy** Refrigerator; Clausius statement of the second law, Carnot's theorem and corollary, The Thermodynamic temperature scale, Absolute zero and Carnot Efficiency, Equality of ideal-gas and Thermodynamic temperatures. **Entropy:** Reversible part of second law (Clausius' theorem), Entropy, Entropy of an ideal gas, T-S diagram, Entropy and reversibility, Entropy and irreversibility, Irreversible part of the second law, Heat and Entropy in irreversible process, Entropy and nonequilibrium states, Principle of increase of entropy, Application of the entropy principle, Entropy and disorder. Heat and Thermodynamics By: M W Zemansky & R H Dittman: [6.7, 7.4, 7.5, 7.6, 7.7, 8.1, 8.2, 8.4, 8.5, 8.6, 8.7, 8.8, 8.9, 8.10, 8.11, 8.12, 8.13]	50%
2.	**Heat and Thermodynamics** **Pure substances:** PT diagram for a pure substance; Phase diagram, Equations of state, T-S diagram for a pure substance Characteristic functions, Enthalpy, Helmholtz and Gibb's functions, Two mathematical theorems, Maxwell's Relations, T-dS equations, Internal Energy equations, Heat capacity equations. Heat and Thermodynamics By: M W Zemansky & R H Dittman [9.2, 9.4, 9.9, 10.1, 10.2, 10.3, 10.4, 10.5, 10.6, 10.7, 10.8,]	50%

Teaching-Learning Methodology	Direct Teaching through Chalk-Walk and Talk ICT enabled teaching Question-Answer Class discussion led by teacher/students Case Studies Literature review Problem solving activities Debate Collaborative and Co-operative Learning Think Pair Share Jigsaw Inquiry Based Learning Panel Discussion Project Based Learning Flipped Classroom Blended Learning designs Concept Mapping

Evaluation Pattern		
Sr. No.	**Details of the Evaluation**	**Weightage**
1.	Internal Continuous Assessment in the form of Internal Written Test, Quizzes, Assignments, Active learning, Viva-voce, Seminars, Attendance (As per NEP Guideline)	50%
2.	University Examination	50%

Course Outcomes: Having completed this course, the learner will be able to	
1.	The laws and mathematical formulations of thermodynamics, the concept of entropy etc.
2.	The behaviour of different states of matter under thermal environment.
3.	The fundamental concept of statistical mechanics like phase space, micro canonical ensemble as isolated system and canonical ensembles which allows exchange of energy.
4.	The partition functions and MB, BE, FD statistical distribution of particles with distinct intrinsic properties such as classical gas, Fermionic gas and Bosonic gas etc.

Suggested References:	
Sr. No.	**References**
1.	Heat & Thermodynamics Mark W. Zemansky & R H Dittman (7th Edition) McGraw-Hill Book Company, Inc.
2.	Heat and Thermodynamics Brij Lal and Subrahmanyam. S Chand Publication.
3.	Thermal Physics by A. B. Gupta, H. P. Roy (New central Publication)

On-line resources to be used if available as reference material

On-line Resources

- https://youtu.be/99W1irInFUY?si=tnOXHYalJ9FGQ2h_
- https://en.wikipedia.org/wiki/Clausius_theorem
- https://en.wikipedia.org/wiki/Temperature%E2%80%93entropy_diagram#:~:text=In%20thermodynamics%2C%20a%20temperature%E2%80%93entropy,the%20graph%20of%20a%20curve.
- https://en.wikipedia.org/wiki/Helmholtz_free_energy
- https://www.youtube.com/watch?v=fZmP2o9LPz8

Bachelor of Science
B.Sc. Physics Practical (Semester – V)

Course Code	US05MIPHY02	**Title of the Course**	Physics Practical
Total Credits of the Course	02	**Hours per Week**	04

Course Objectives:	1. To learn by performing experiments based on principles and applications. 2. To have working knowledge of equipment like thermocouple, telescope and electronic circuits. 3. To have the working knowledge of experiments related to Thermodynamics, optics, mechanics, electrodynamics, analog and digital electronics etc.

Course Content	
Description	**Weightage (%)**
1. To calibrate thermocouple using potentiometer 2. Velocity of sound by resonance tube 3. Study of transformer parameters 4. Resolving power of telescope 5. 'L' by Owen's bridge 6. Characteristics of LDR 7. Numerical differentiation 8. To determine Boltzmann's constant using PN junction diode 9. Characteristics of BJT in CE configuration	100%

NOTE	Minimum 80% practical should be performed. To provide flexibility up to the maximum of 20% of total experiments can be replaced/ added to the list by respective colleges

Evaluation Pattern		
Sr. No.	**Details of the Evaluation**	**Weightage**
1.	Internal Continuous Assessment in the form of Internal Written Test, Quizzes, Assignments, Active learning, Viva-voce, Seminars, Attendance (As per NEP Guideline)	50%
2.	University Examination	50%

Course Outcomes: Having completed this course, the learner will be able to	
1.	various characteristics of velocity of sound, resolving power of telescope, light dependent resistor etc.
2.	deduce numerical methods to analyze the observational data as well as the applications of numerical methods to solve dynamics of Physics problems.
3.	study various oscillatory circuits, transistor characteristics, diode circuits and bridge circuits.

Suggested References:

Sr. No.	References
1.	Advanced Practical Physics for students B L Worsnop and H T Flint, Methuen and Co. Ltd., London
2.	B.Sc. Practical Physics C L Arora, S. Chand & Co. Ltd., New Delhi
3.	Advanced Practical Physics M S Chauhan and S P Singh, Pragati Prakashan, Meerut
4.	Advanced Practical Physics S L Gupta and V Kumar, Pragati Prakashan, Meerut
5.	An advanced course in practical Physics D Chattopadhyay and P C Rakshit, New Central book agency Pvt. Ltd

On-line resources to be used if available as reference material

On-line Resources

THERMOCOUPLE
https://alllabexperiments.com/wp-content/uploads/2020/12/Thermocouple-Caliberation-All-Lab-Experiments.compressed_compressed.pdf
FOUR PROBE METHOD
https://vlab.amrita.edu/?sub=1&brch=282&sim=1512&cnt=3
https://vlab.amrita.edu/?sub=1&brch=282&sim=1512&cnt=3
'Y' BY KOENIG'S METHOD
https://www.scribd.com/document/773198194/Young-s-Modulus-Koenig-s-Method
https://www.youtube.com/watch?v=V_z0AgbyfeM
RESOLVING POWER OF TELESCOPE
https://www.youtube.com/watch?v=FeIdFtcYQXg
LIGHT DEPENDENT RESISTOR
https://www.electrical4u.com/light-dependent-resistor-ldr-working-principle-of-ldr/
SOLAR CELL CHARACTERISTICS
https://www.iitr.ac.in/departments/PH/uploads/Teaching%20Laboratory/Thermal/2.%20solar%20cell.pdf
https://www.youtube.com/watch?v=1BlUC8nYuTs

Bachelor of science
B.Sc. Physics Semester-5

Course Code	US05MIPHY03	**Title of the Course**	Renewable Energy Sources
Total Credits of the Course	2	**Hours per Week**	2

Course Objectives:	1. To make the students aware about the different renewable energy sources such as solar, geothermal, wind and fuel cells and technological advancements in this field. 2. To make the students aware of the importance of using nonconventional energy resources and their utilization for the present day and future energy needs.

Course Content		
Unit	**Description**	**Weightage (%)**
1.	**Solar Thermal Energy Conversion Systems** Introduction, Subsystems, Solar Thermal Collectors, Characteristics feature of a collectors, Important aspects of solar thermal Collectors, Collector Efficiency, Simple Flat plate Collectors, Installation of Flat Plate Collectors, Guidelines for Installation, Shadow Effect, Cosine loss factor and reflective Loss Factor, Parabolic through collectors, Paraboloidal dish collectors, Fresnel lens point focus collector, Heliostats with Central Receiver. **Solar Photovoltaic Systems:** Introduction to Photovoltaic systems, Merits and Limitations of Solar PV Systems, Principle of a Photo-Voltaic cell, V-I characteristics of Solar Cell, Interconnections of solar cells, Efficiency of a solar cell, Configuration of a solar PV Panel Energy Technology Nonconventional, Renewable and Conventional S Rao and Dr. B B Parulekar [4.1, 4.2, 4.3, 4.3.1, 4.3.2, 4.5, 4.6, 4.7, 4.8, 5.1, 5.2, 5.5, 5.6, 5.7, 5.8, 5.10]	50%
2.	**Fuel Cells and Fuel Cell Power Plants** Introduction, Advantages of Fuel Cell Power Sources, Theory of Electro-Chemistry applied to fuel Cells, Principle and Operation of fuel Cells, H2-O2 Acidic fuel Cell, Alkaline H2-O2 fuel Cell, Classification and Types of Fuel Cells, Fuels for Fuel Cells, Performance Characteristics of Fuel Cells-Voltage Vc-Current Density I_d Characteristic (Polarization Curve), Power per cell P_c, Cell Efficiency. Energy Technology Nonconventional, Renewable and Conventional S Rao and Dr. B B Parulekar [23.1, 23.2, 23.3, 23.4, 23.5, 23.6, 23.8]	50%

Teaching-Learning Methodology	Direct Teaching through Chalk-Walk and Talk ICT enabled teaching Question-Answer Class discussion led by teacher/students Case Studies Literature review Problem solving activities Debate Collaborative and Co-operative Learning Think Pair Share Jigsaw Inquiry Based Learning Panel Discussion Project Based Learning Flipped Classroom Blended Learning designs Concept Mapping

Evaluation Pattern

Sr. No.	Details of the Evaluation	Weightage
1.	Internal Continuous Assessment in the form of Internal Written Test, Quizzes, Assignments, Active learning, Viva-voce, Seminars, Attendance (As per NEP Guideline)	50%
2.	University Examination	50%

Course Outcomes: Having completed this course, the learner will be able to understand

1.	The various sources of renewable energy and their conversion methods.
2.	They will be able to gain the knowledge of various fuel cells and power plants.

Suggested References:

Sr. No.	References
1.	Energy Technology (Nonconventional, Renewable and Conventional) S Rao and Dr. B B Parulekar Khanna Publishers (3rd Edition), 2004.
2.	Instrumentation Measurement and Analysis B C Nakra and K K Chaudhary Tata McGraw Hill Publishing Co. Ltd., New Delhi

On-line resources to be used if available as reference material
On-line Resources
https://en.wikipedia.org/wiki/Solar_thermal_collector https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000014ER/P000277/M025048/ET/1511327817Paper7_EnergyEnv_module_15_etext-SolarCollectors.pdf https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=video&cd=&cad=rja&uact=8&ved=2ahUKEwihp9eF9cqLAxV2ulYBHeZfL1kQtwJ6BAgXEAI&url=https%3A%2F%2Fwww.youtube.com%2Fwatch%3Fv%3DhGZva0QYN8A&usg=AOvVaw13c-CXitq0sBOb3HZnxA8j&opi=89978449 https://en.wikipedia.org/wiki/Photovoltaic_system https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=video&cd=&cad=rja&uact=8&ved=2ahUKEwjdi_Pe9cqLAxW2hlYBHXrNIDQQtwJ6BAgPEAI&url=http%3A%2F%2Fdigimat.in%2Fnptel%2Fcourses%2Fvideo%2F117108141%2FL01.html&usg=AOvVaw1Ykf6N-EUCzj0lRbyefpT7&opi=89978449 https://en.wikipedia.org/wiki/Fuel_cell https://en.wikipedia.org/wiki/Alkaline_fuel_cell#:~:text=Alkaline%20fuel%20cells%20consume%20hydrogen,the%20potential%20to%20reach%2070%25.&text=NASA%20has%20used%20alkaline%20fuel,and%20on%20the%20Space%20Shuttle https://www.sciencedirect.com/topics/earth-and-planetary-sciences/hydrogen-oxygen-fuel-cells

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Bachelor of Science
B.Sc. Physics Practical (Semester – V)

Course Code	US05MIPHY04	**Title of the Course**	Physics Practical
Total Credits of the Course	02	**Hours per Week**	04

Course Objectives:	1. To acquire knowledge and develop understanding of concepts, fundamental laws, principles and processes in the area of physics. 2. To have working knowledge of equipment like viscometer, CRO and electronic circuits. 3. To have the working knowledge of experiments related to spectroscopy, magnetostatics, optics, electronics etc.

Course Content	
Description	**Weightage (%)**
1. To find viscosity co-efficient of liquid using co-axial viscometer 2. To determine charge of electron 'e' (Benzene, hollow prism) 3. To find energy bandgap of a semiconducting material 4. Frequency and phase angle by CRO 5. e/K by power transistor 6. Least square error fitting method 7. Solar cell characteristics 8. Planck's constant by LED 9. 'L' by Maxwell's bridge	100%

NOTE	Minimum 80% practical should be performed. To provide flexibility up to the maximum of 20% of total experiments can be replaced/ added to the list by respective colleges

Evaluation Pattern		
Sr. No.	**Details of the Evaluation**	**Weightage**
1.	Internal Continuous Assessment in the form of Internal Written Test, Quizzes, Assignments, Active learning, Viva-voce, Seminars, Attendance (As per NEP Guideline)	50%
2.	University Examination	50%

Course Outcomes: Having completed this course, the learner will be able to	
1.	calculate various properties of materials like resistivity, band gap of semiconductor etc.
2.	deduce numerical methods to analyze errors in measurement.
3.	study solar cell, cathode ray oscilloscope, power transistor light emitting diode etc.

Suggested References:

Sr. No.	References
1.	Advanced Practical Physics for students B L Worsnop and H T Flint, Methuen and Co. Ltd., London
2.	B.Sc. Practical Physics C L Arora, S. Chand & Co. Ltd., New Delhi
3.	Advanced Practical Physics M S Chauhan and S P Singh, Pragati Prakashan, Meerut
4.	Advanced Practical Physics S L Gupta and V Kumar, Pragati Prakashan, Meerut
5.	An advanced course in practical Physics D Chattopadhyay and P C Rakshit, New Central book agency Pvt. Ltd
6.	An Advanced Course In Practical Physics D Chattopadhyay and P C Rakshit, New Central book agency Pvt. Ltd.

On-line resources to be used if available as reference material

On-line Resources

SUSCEPTIBILITY OF PARAMAGNETIC/FERROMAGNETIC SOLUTION BY QUINK'S METHOD
https://www.holmarc.com/magnetic_susceptibility_quinke.php#:~:text=The%20Quincke's%20Method%20is%20used,a%20non%2Duniform%20magnetic%20field.&text=Measuring%20this%20rise%20enables%20to%20determine%20the%20susceptibility%20of%20the%20solution.
https://www.youtube.com/watch?v=yzgdq8uUfO4

PHASE ANGLE BY C.R.O.
https://www.tutorialspoint.com/electronic_measuring_instruments/electronic_measuring_instruments_lissajous_figures.htm

https://www.uoanbar.edu.iq/eStoreImages/Bank/5301.pdf

TO DETERMINE BOLTZMANN'S CONSTANT USING PN JUNCTION DIODE
https://www.vlab.andcollege.du.ac.in/phySc/electronics/boltzmanC/boltzmanF.html

e/K BY POWER TRANSISTOR
https://www.youtube.com/watch?v=lw09mNgzMGI
https://www.tumblr.com/bingqingli/42926778926/ek-and-band-gap

LOAD LINE AND DETERMINATION OF Q POINT USING BJT
https://www.tutorialspoint.com/basic_electronics/basic_electronics_transistor_load_line_analysis.htm

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Bachelor of Science
B.Sc. Physics Semester–V

Course Code	US05SEPHY01	**Title of the Course**	Hands-on Experimental Skills in Physics
Total Credits of the Course	02	**Hours per Week**	04

Course Objectives:	1. To provide hands-on experience and reinforce theoretical knowledge by designing, building, testing, and troubleshooting real-world electronic systems. 2. To familiarize students with various electronic devices and their specifications. 3. To develop skill for Design and Testing of different types of electronic subsystems using various integrated circuits. 4. Develop skills of writing a structured technical document for project and its presentation. 5. Develop ability to diagnose faults and their rectification.

Course Content

Description	**Weightage (%)**
1. Adjustable Flashing/Blinking LED Circuit using 555 Timer IC 2. Police Lights Themed Flashing LED Circuit Using 555 IC 3. Touch On-Off Sensor Switch Circuit Using 555 Timer IC 4. Model Traffic Lights Circuit Using 555 IC 5. Simple Water Level Indicator with Alarm Using Transistors 6. Water Level Alarm Using 555 Timer 7. Panic Alarm Circuit 8. Rain Alarm Project: Rain Detector Project 9. Automatic Street Light Control Circuit using LDR & Transistor BC 547 10. Half Adder Circuit Diagram with Logic IC 11. Full Adder Circuit Diagram with Logic IC	100%

NOTE	Minimum 80% practical should be performed. To provide flexibility up to the maximum of 20% of total experiments can be replaced/ added to the list by respective colleges

Sr. No.	**Work done**	**Weightage as per 50 Marks**
1.	Project demonstration	10 Marks
2.	Project presentation	10 Marks
3.	Student involvement and understanding	10 Marks
4.	Viva-voce	10 Marks
5.	Project report	10 Marks
	Total Marks	**50 Marks**

Evaluation Pattern		
Sr. No.	**Details of the Evaluation**	**Weightage**
1.	Internal Continuous Assessment in the form of Understanding project objectives, Background knowledge of Project/ Subject, Assignments, Active learning, Viva-voce, Knowledge on the Content, Attendance (As per NEP Guideline)	50%
2.	University Examination	50%

Course Outcomes: Having completed this course, the learner will be able to	
1.	design, test and implement any Analog or Digital circuit by making use of the various tools and instruments available in the Electronics Workshop.
2.	enable students to understand, analyze, design, and implement electronic circuits and systems.
3.	apply their knowledge to solve real-world problems, develop innovative solutions, and adapt to changing project requirements

Suggested References:	
Sr. No.	**References**
1.	Electronics Lab Manual, Volume I K. A. Navas, PHI, 5th Edition, 2015
2.	Electronics Projects (Volume 1 to 19) Ramesh Chopra for Electronics for You (EFY) Enterprises Pvt. Ltd., New Delhi
3.	Electronics Projects for Beginners Nikhil Shukla, V & S Publishers, 2017
4.	Electronic Projects in Workshop R.A Penfold, Newnes Technical Books

On-line resources to be used if available as reference material
On-line Resources
Adjustable Flashing/Blinking LED Circuit using 555 Timer IC https://elonics.org/adjustable-led-flasher-using-555-timer/ Police Lights Themed Flashing LED Circuit Using 555 IC https://elonics.org/police-lights-themed-flashing-led-circuit-using-555-ic/ Touch On-Off Sensor Switch Circuit Using 555 Timer IC https://elonics.org/touch-on-off-sensor-switch-using-555-timer-ic/ Model Traffic Lights Circuit Using 555 IC https://elonics.org/model-traffic-lights-circuit-using-555-ic/ Simple Water Level Indicator with Alarm Using Transistors Water Level Alarm Using 555 Timer https://www.electronicshub.org/water-level-alarm-using-555-timer/ Panic Alarm Circuit https://www.electronicshub.org/panic-alarm/ Rain Alarm Project: Rain Detector Project https://www.electronicshub.org/rain-alarm-project/ Automatic Street Light Control Circuit using LDR & Transistor BC 547 https://www.electricaltechnology.org/2013/04/automatic-street-light-control.html Half Adder Circuit Diagram with Logic IC https://theorycircuit.com/digital-electronics/half-adder-circuit-diagram-with-logic-ic/ Full Adder Circuit Diagram with Logic IC https://theorycircuit.com/digital-electronics/full-adder-circuit-diagram-with-logic-ic/

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