Bachelor of Science B.Sc. Honours
Physics (Semester - VII)

Course Code	US07HMAPHY01	Title of the Course	Mathematical Methods
Total Credits of the Course	4	Hours per Week	4
Course Objectives:	1. To provide the concept of generalized curvilinear coordinates and their vector differential operators and its deduction for the cases of rectangular, cylindrical and spherical coordinates. 2. To provide the basic definition and applications of Beta, Gamma and harmonic functions to solve physical problems. 3. To train the students in the applications of Fourier series for solving certain special classes of physical problems. 4. To provide various numerical techniques useful for scientific data analysis as well as to train how to find the differentiation and integration of numerical data.		

Course Content		
Unit	Description	Weightage* (%)
1.	**<u>Curvilinear Co-ordinate System and Beta, Gamma Functions</u>** **Curvilinear Coordinate System:** Curvilinear Coordinates, Orthogonal curvilinear coordinates, Condition for orthogonality, Reciprocal sets of two triads of mutually orthogonal vectors, Gradient in terms of orthogonal curvilinear coordinates, Divergence in terms of orthogonal curvilinear coordinates, Curl in terms of curvilinear coordinates, Laplacian in terms of orthogonal curvilinear coordinates, Equivalent expression for $\nabla\emptyset, \nabla \cdot F$ and $\nabla \times F$ (gradient, div and curl) in rectangular coordinates, Cylindrical coordinates as a special curvilinear system, Spherical polar coordinates as a special curvilinear system, Related Numerical, **Beta, Gamma Functions** Definitions, Fundamental property of Gamma Functions, Transformation of Gamma Function, Relation: $\beta(m,n) = \beta(n,m)$, Different forms of Beta function, Relation between Beta and Gamma Functions [Mathematical Physics by B. D. Gupta (4th Edition): 1.36, 1.37, 1.38, 1.39, 1.40, 1.41, 1.42, 1.43, 1.44, 1.45, 1.46, 6.1, 6.2, 6.4, 6.5, 6.6, 6.7]	25%
2.	**<u>Harmonics with Special Functions</u>** Legendre differential equation(Solution in descending power of x), Legendre polynomials(without corollary), Generating functions for $P_n(x)$, Recurrence formulas for $P_n(\mu)$, Rodrigue's formula, Orthogonal properties of Legendre polynomials of the first kind, Bessel's differential equation, Generating functions for$J_n(x)$, Recurrence formula for $J_n(x)$, Orthogonal properties of Bessel's polynomials, Hermite's differential equation, Hermite polynomials, Recurrence formula for $H_n(x)$, Orthogonal properties of Hermite polynomials [Mathematical Physics by B. D. Gupta (4th Edition): 8.3A, 8.3B, 8.3C, 8.3E, 8.3f$_2$, 8.3G, 8.4A, 8.4B, 8.4D, 8.4E, 8.7A, 8.4B, 8.4D, 8.4F]	25%

3.	**Fourier series, Diffusion Equation and Wave Equation** Definition and expansion of a function of x, Complex representation of Fourier's series, Physical application of Fourier's series: Fourier series involving phase angles, Effective values and the average of a product, Thermal state, Transverse vibration of a string, Diffusion equation or Fourier equation of heat flow, Independent derivation of one dimensional diffusion equation, Solution of one dimensional diffusion equation when both the ends of a bar at temperature zero, Two-dimensional diffusion equation, **The Wave Equations:** Derivation of one-dimensional wave equation, Derivation of Two-dimensional wave equation, Related Numerical [Mathematical Physics by B. D. Gupta (4^{th} Edition): 9.1, 9.4, 9.9, 9.9(1), 9.9(2), 9.9(3), 9.9(4), 12.2, 12.3A, 12.3B(b_1), 12.4, 12.10A, 12.10B]	25%
4.	**Numerical Techniques** **Curve Fitting:** Introduction, **The Least squares method**: Fitting a straight line, Fitting a parabola, Fitting a curve of the form $y = ax^b$, Fitting an exponential curve$y = ae^{bx}$ **Interpolation:** Introduction, Finite difference operator: Forward, Backward and Central Differences, Shift, Average and Differential operator, Newton's forward difference interpolation formula, Newton's backward difference interpolation formula, Lagrange's interpolation formula **Numerical differentiation and integration:** Differentiation using difference operators (Forward and Backward), Newton- Cotes Integration formula, The Trapezoidal Rule, Simpson's (1/3) Rule, Related Numerical [Numerical Methods for Scientists and Engineers by K Sankara Rao (3^{rd} Edition): 5.1, 5.3, 5.3.1, 5.3.2, 5.3.3, 5.3.4, 6.1, 6.2, 6.2.1, 6.2.2, 6.2.3, 6.3, 6.4, 6.5, 7.1, 7.2, 7.6, 7.6.1, 7.6.2]	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: At the end of course, students will be expected to have learnt	
1.	The general features of curvilinear coordinate systems and their deductions to any coordinate system.
2.	The importance of some special harmonic functions and their properties.
3.	How Fourier series can be applied to solve certain types of differential equations.
4.	The students will be able to apply numerical methods for solving various physical problems which are difficult to study analytically as well as how to analyze the experimental data.

Suggested References:	
Sr. No.	References
1.	Mathematical Physics B D Gupta (4th Edition) Vikas Publishing House Pvt. Ltd.
2.	Mathematical Methods in Physical Science Mary L Boas (2nd Edition) John Wiley & Sons
3.	Mathematical Methods for Physics George B. Arfken and Hans J. Weber (4th Edition) Academic Press, INC
4.	Numerical Methods for Scientists and Engineers K Sankara Rao (3rd Edition) PHI Learning Pvt. Ltd.
5.	Numerical Methods E Balagurusamy, Tata McGraw Hill Publishers
6.	Numerical Mathematical Analysis J B Scarborough Oxford & IBH Publishing Pvt. Ltd.

Online resources to be used if available as reference material
Online Resources
https://en.wikipedia.org/wiki/Curvilinear_coordinates https://en.wikipedia.org/wiki/Beta_function https://en.wikipedia.org/wiki/Legendre_polynomials https://en.wikipedia.org/wiki/Bessel_function https://en.wikipedia.org/wiki/Fourier_series

Bachelor of Science B.Sc. Honours
Physics (Semester-VII)

Course Code	US07HMAPHY02	Title of the Course	Thermodynamics and Statistical Mechanics
Total Credits of the Course	4	Hours per Week	4

Course Objectives:	1. To provide the fundamentals of thermodynamics and their applications to study 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]	25%
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, Joule-Thompson expansion. 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, 11.1]	25%

3.	**Fundamentals of Classical Statistical Mechanics** Macroscopic and Microscopic states, Phase space, Liouville's theorem, Fluctuations in a physical quantity, Microcanonical Ensemble: Microcanonical distribution, Equal a priori probability, Entropy, Entropy of a perfect gas in a Microcanonical ensemble, Gibbs paradox, Removal of Gibbs paradox, Thermodynamic quantities in a Microcanonical ensemble, Average energy per particle, Specific heat at constant volume, Sackur- Tetrode formula, Nernst's heat theorem, Canonical Ensemble: Canonical distribution, Canonical average, Canonical partition function, Related Numerical [A Textbook of Statistical mechanics, Suresh Chandra and Mohit Kumar Sharma: 2.1,2.2,2.4,2.6,3.1,3.2,3.3,3.4,3.5,3.5.1, 3.6,3.7, 3.8,4.1,4.1.1,4.2]	25%
4.	**Partition Functions and Statistical Distribution** Grand Canonical Ensemble: Grand Canonical distribution, Grand Canonical average, Grand Canonical partition function. Three Distributions: Maxwell- Boltzmann Distribution, Fermi-Dirac distribution, Bose-Einstein Distribution, Applications of Maxwell-Boltzmann Distribution: Energy distribution function, Energy distribution law, Partition function, Most probable energy, Total number of particles, Average energy, Velocity distribution function, Total number of particles, Most probable velocity, Average velocity and Root mean square velocity, Related Numerical [A Text Book of Statistical mechanics By: Suresh Chandra and Mohit Kumar Sharma: 5.1,5.1.1,5.2,6.1,6.2,6.3,6.4,7.1,7.1.1, 7.1.2, 7.1.3, 7.1.4, 7.1.5,7.1.6,7.2,7.2.1,7.2.2,7.2.3,7.2.4]	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.	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 (7th Edition) McGraw-Hill Book Company, Inc.
2.	A textbook of Statistical Mechanics Suresh Chandra CBS Publishers & Distributers
3.	Heat and Thermodynamics Brij Lal and Subrahmanyam. S Chand Publication.
4.	Statistical Mechanics B K Agarwal and Melvin Eisner New Age International Limited Publishers
5.	Fundamentals of Statistical Mechanics B. B. Laud New Age International publishers

Online resources to be used if available as reference material

Online Resources

Resource Type: Reference

1. Introduction to Thermodynamics and Statistical Mechanics by David Albert
https://www.youtube.com/awatch?v=8Ku6_7J2c6I&feature=youtu.be
2. Thermodynamics 5e - Statistical Mechanics V
https://www.youtube.com/watch?v=S9OulbNy2_4&feature=youtu.be
3. Thermodynamics 5d - Statistical Mechanics IV
https://www.youtube.com/watch?v=TI5mG2bkvd4&feature=youtu.be
4. Thermodynamics 5a - Statistical Mechanics I
https://www.youtube.com/watch?v=cOalyjCkHIc&feature=youtu.be
5. Thermodynamics 5c - Statistical Mechanics III
https://www.youtube.com/watch?v=jUYK-wD4VUg&feature=youtu.be
6. Relation between Statistical Mechanics and Thermodynamics Derivation | Entropy and Probability.
https://www.youtube.com/watch?v=rV9vjjT9lFU&feature=youtu.be
7. Statistical Thermodynamics l Mechanics | Asst. Prof. Aditi Joshi
https://www.youtube.com/watch?v=hAGewYa5Hn8&feature=youtu.be
8. B Sc Phy.Sem 5 US05CPHY23 Thermodynamics &Statistical Mechanics Unit1Thermodynamical Laws&Entropy-13
https://www.youtube.com/watch?v=sYs_y27w11I&feature=youtu.be
9. Statistical Thermodynamics - Midnight Crash Course
https://www.youtube.com/watch?v=BwIUE1C6Iwk&feature=youtu.be
10. Statistical Thermodynamics || Lecture 1 || IIT JAM | DU | BHU | NET || By Manjeet Sir
https://www.youtube.com/watch?v=MkqQ6DrmaFc&feature=youtu.be
11. Zeroth laws and first law of Thermodynamics/ Lec-6 / Thermodynamics and Statistical mechanics
https://www.youtube.com/watch?v=DrkXs5kQXOY&feature=youtu.be
12. ICTP MediaCore Statistical mechanics Lecture 1 of 29
https://www.youtube.com/watch?v=iha9t8-BztE&feature=youtu.be
13. What is Statistical Mechanics | Beautiful discussion of beautiful Subject | Statistical Mechanics
https://www.youtube.com/watch?v=5L5L-Nlvnho&feature=youtu.be

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

Course Code	US07HMAPHY03	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
SECTION A: 1. Capacitance by de Sauty's method 2. Study of Hysteresis curve 3. Resonance pendulum 4. Thickness of a thin wire using optical bench 5. Determination of lattice parameter by X-ray from a photograph (powder method) 6. Dissociation of I_2 molecules 7. Searle's Goniometer (Fixed distance)
SECTION B: 1. Flip-flops (RS, JK, D) 2. MOSFET characteristics 3. Solar cell characteristics 4. Amplitude modulation and demodulation 5. FET amplifier- Common Source- study of frequency response. 6. Laser beam divergence and spot size (Computer simulation) 7. Numerical differentiation (computer related)

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.	Demonstrate understanding of fundamental physical principles such as capacitance, magnetism, resonance, diffraction, crystal structure, and thermodynamic equilibrium through laboratory experiments.
2.	Analyze and interpret experimental data related to solid state physics, electronics, and modern physics, including lattice parameter determination, hysteresis characteristics, semiconductor device behavior, and solar cell performance.
3.	Design, construct, and evaluate electronic circuits such as flip-flops, MOSFET characteristics and modulation-demodulation systems, and study their characteristics and frequency response.

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

Online resources to be used if available as reference material
Online Resources
STUDY OF HYSTERISIS CURVE https://www.youtube.com/watch?v=iO4bSZjfZoI X-ray powder method https://web.stanford.edu/group/glam/xlab/MatSci162_172/LectureNotes/04_Powder%20Diffraction,%20Powder%20Method.pdf DISSOCIATION OF I_2 MOLECULES https://www.jamia-physics.net/lecnotes/lab/iodine-new.pdf SEARL'S GONIOMETER https://www.youtube.com/watch?v=RSLE0rWnRBs FLIP FLOPS https://www.youtube.com/watch?v=4b8VW0X6nj4 AMPLITUDE MODULATION AND DEMODULATION https://vlab.amrita.edu/index.php?sub=59&brch=163&sim=259&cnt=362 LASER BEAM DIVERGENCE AND SPOT SIZE https://lo-amrt.vlabs.ac.in/exp/laser-beam-divergence/theory.html COMMON SOURCE FET AMPLIFIER https://www.semiconductorforu.com/fet-circuit-basics-classification-working-and-its-applications/

Bachelor of Science B.Sc. Honours
Physics (Semester-VII)

Course Code	US07HMIPHY01	Title of the Course	Defects in Solids and Diffusion Process
Total Credits of the Course	2	Hours per Week	2

Course Objectives:	1. To describe and classify and various types of defects in crystalline solids. 2. To explain vacancy, self-interstitial, dislocations and grain boundaries. 3. To discuss various diffusion mechanisms in solids, including vacancy diffusion, interstitial diffusion and nonsteady-state diffusion.

Course Content		
Unit	Description	Weightage* (%)
1.	**Imperfections in Solids** Introduction, Point defects, Vacancies and self-interstitials, Self-interstitial, Impurities in solids, Solid solutions, Specification of composition, Composition conversions, Dislocations-Linear defects, edge dislocation, Screw dislocation, Mixed dislocations, Burger vectors, Interfacial defects, External surfaces, Grain boundaries, Phase boundaries, Twin boundaries, Bulk or volume defects, Atomic vibrations, Grain-size determination. [Materials Science and Engineering-An Introduction by William D. Callister, Jr. and David G. Rethwisch: 4,1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.6, 4.7, 4.11]	50%
2.	**Diffusion** Introduction, Interdiffusion, Self-diffusion, Diffusion Mechanics, Vacancy diffusion, Interstitial diffusion, Fick's first law, Diffusion flux, Diffusion coefficient, Steady-state diffusion, Fick's second law - Nonsteady-state diffusion, Factors that influence diffusion, Diffusing spices, Temperature, Diffusion in semiconducting materials. [Materials Science and Engineering-An Introduction by William D. Callister, Jr. and David G. Rethwisch: 5.1, 5.2, 5.3, 5.4, 5.5, 5.6]	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.	Define different types of crystal defects, diffusion mechanisms, and fundamental laws governing diffusion in solids.
2.	Explain the formation and composition of defects in crystalline solids and describe various diffusion processes.
3.	Apply Fick's Laws to solve numerical problems related to steady-state and non–steady-state diffusion and calculate diffusion coefficients and activation energy.

Suggested References:

Sr. No.	References
1.	Materials Science and Engineering-An Introduction by William D. Callister, Jr. and David G. Rethwisch (Tenth Edition)
2.	Fundamentals of solid state physics by Saxena, B. S., Gupta, R. C., & Saxena, P. N. (1993) Pragati Prakashan.
3.	Introduction to Dislocations by Bacon, D. J., Hull, D. (2011), Elsevier Science, fifth edition
4.	The Science and Engineering of Materials by Askeland, D.R., Fulay P. R. & Wright W. J. (2010). Cengage Learning, Stamford, CT, USA.

Online resources to be used if available as reference material

Online Resources

Resource Type: Reference

1. Point Defects: Vacancies, Interstitials, Impurities
   https://www.youtube.com/watch?v=EDJxKW5ZRHI
2. Point Defects {Texas A&M: Intro to Materials}
   https://www.youtube.com/watch?v=EuUJApDftkI
3. Diffusion in a Crystal. Vacancy and Interstitial mechanisms
   https://www.youtube.com/watch?v=aHYbhUKaT6Y
4. Edge, screw and mixed dislocations
   https://www.youtube.com/watch?v=1aFgLJcVyaQ
5. Grain Boundary
   https://www.youtube.com/watch?v=mQOafZRdOjA
6. Crystal Defects - Types and Classifications Explained in Detail
   https://www.youtube.com/watch?v=FPTjuTRBGSc
7. Diffusion (Diffusion Mechanisms)
   https://www.youtube.com/watch?v=HpozI-sXhTQ
8. Fick's Second Law
   https://www.youtube.com/watch?v=1DfR61pi4Ho

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

Course Code	US07HMIPHY02	Title of the Course	Physics Practical
Total Credits of the Course	02	Hours per Week	04

Course Objectives:	1. To understand the fundamental principles of oscillatory motion and mechanical properties of materials. 2. To study the magnetic behavior of materials by determining the magnetic susceptibility of paramagnetic and ferromagnetic solutions. 3. To apply the principles of wave optics for determining the wavelength of light. 4. To understand the characteristics and applications of semiconductor devices and electronic circuits. 5. To apply basic mathematical concepts such as matrices in scientific computations and problem solving.

Course Content
Description
1. Resonance pendulum 2. Susceptibility of paramagnetic/ferromagnetic solution by Quink's method 3. Newton's rings 4. Modulus of rigidity 'η' by Maxwell's needle 5. Zener diode characteristics 6. RC phase shift oscillator 7. Common source FET amplifier – Study of frequency response 8. Study of Matrices

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.	To understand and perform experiments related to mechanical and oscillatory systems.
2.	To analyse magnetic properties of materials by determining magnetic susceptibility. And to apply optical principles to determine wavelength and related parameters.
3.	To study and analyze electronic circuits including Zener diode characteristics, RC phase shift oscillator, and FET amplifier frequency response

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

Online resources to be used if available as reference material
Online Resources
RESONANCE PENDULUM https://spark.iop.org/resonance-pendulum QUINK'S METHOD https://www.youtube.com/watch?v=e2qFLn_3heA NEWTON'S RING https://iitr.ac.in/Academics/static/Department/Physics/BTech%201st%20year%20lab/Newtons_Ring.pdf ZENER DIODE CHARACTERISTICS https://www.youtube.com/watch?v=ryB36ixUp4w RC PHASE SHIFT OSCILLATOR https://www.pcepurnia.org/wp-content/uploads/2020/03/RC-Phase-Shift-Oscillator.pdf COMMON SOURCE FET AMPLIFIER https://www.youtube.com/watch?v=aDzgtndyGEY

Bachelor of Science B.Sc. Honours
Physics (Semester-VII)
(MODE-2: For B.Sc. Honours (without research-OJT)

Course Code	US07HMAPHY04	Title of the Course	On-the-job Training (OJT)
Total Credits of the Course	6	Hours per Week	30

Course Objectives:	1. To provide practical exposure to students in real working environments such as industries, research laboratories, academic institutions, or technical organizations related to their field of study. 2. To bridge the gap between theoretical knowledge and practical application by enabling students to apply concepts learned during their undergraduate studies to real-life situations. 3. To develop professional skills such as problem solving, teamwork, communication, work ethics, and time management required in professional settings. 4. To develop documentation and reporting skills through preparation of training reports, presentations, and project summaries.

The On-the-job training (OJT) component aims to provide structured industry exposure, application-oriented learning and employability skills to students enrolled in the 4th year UG (Honours) programme, in alignment with NEP-2020 and UGC CCFUP provisions. The successful completion of OJT requires 180 hours of training.

The students are expected to maintain daily diary to record their activities and learning experiences. The grades/marks for OJT will be determined based on the evaluation of both the supervisor **(50%)** and faculty guide **(50%)**. Upon successful completion of OJT, the Skill Knowledge Provider (SKP) can issue a certificate or a completion letter to the students.

Course Outcomes: Having completed this course, the learner will be able to	
1.	Demonstrate the ability to apply theoretical knowledge of their discipline to practical situations in industry, research laboratories, or professional organizations.
2.	Develop technical and professional skills such as problem solving, teamwork, communication, and time management required in real work environments.
3.	Analyze practical problems encountered during training and propose suitable solutions using scientific and analytical approaches.
4.	Prepare and present a structured training report demonstrating their understanding of workplace practices, technologies, and professional ethics.

Bachelor of Science B.Sc. Honours
Physics (Semester - VII)
(MODE-3: For B.Sc. Honours (with Course Work)

Course Code	US07HMAPHY05	Title of the Course	Electronic Communication
Total Credits of the Course	4	Hours per Week	4
Course Objectives:	1. Explain the basic components of communication systems such as transmitter, channel, receiver, transceiver and fundamentals of Amplitude Modulation. 2. Explain the working of amplitude modulation, frequency modulation and phase modulation. 3. To study digital transmission, efficiency, various types of networks, its hardware and internet applications. 4. Understand the principles of satellite communication, including orbits, satellite parameters, and positioning and explain geosynchronous satellites, azimuth and elevation angles, and satellite tracking concepts.		

Course Content		
Unit	Description	Weightage* (%)
1.	**Introduction to Electronic Communication (EC)** The Significance of Human Communication, Communication Systems, Transmitter, Communication channel, Receivers, Transceivers, Types of Electronic Communication, Simplex, Full and Half Duplex, Analog and digital signals, Modulation and Multiplexing, Baseband and broadband transmission, The Electromagnetic Spectrum, Bandwidth. **Amplitude Modulation Fundamentals:** AM Concepts, Modulation Index and Percentage of Modulation, Sidebands and the Frequency Domain, Single-Sideband Modulation, DSB Signals, SSB Signals, Disadvantages of DSB and SSB, Related numerical. [Principles of Electronic Communication systems, Louis E Frenzel Jr.: 1-1, 1-2, 1-3, 1-4, 1-5, 1-6, 3-1, 3-2, 3-3, 3-5]	25%
2.	**Amplitude, Frequency & Phase Modulation** Amplitude Modulator and Demodulator Circuits: Basic Principles of Amplitude Modulation, Amplitude Modulators, Diode Modulator, Transistor Modulator, Differential Amplifier, Amplitude Demodulators, Diode detectors, Basic Principles of Frequency Modulation, Principles of Phase Modulation, Frequency Modulation Versus Amplitude Modulation, Disadvantages of FM, Frequency Modulators, Varactor Modulators, Phase Modulators, Frequency demodulators, Related numerical. [Principles of Electronic Communication systems, Louis E Frenzel Jr.: 4-1, 4-2, 4-3, 5-1, 5-2, 5-5, 6-1, 6-2, 6-3]	25%

3.	**Digital Data Transmission** Digital Codes, Principles of Digital Transmission, Serial Transmission, Transmission Efficiency, Hartley's law, Modem Concepts and Methods, Frequency-shift keying (FSK), Network Fundamentals, Types of networks, Wide-Area Networks, Metropolitan-Area Networks, Local-Area Networks, Network Topologies, star topology, ring topology, bus topology, mesh topology, LAN Hardware, Coaxial cable, Twisted-pair cable, Fiber-optic cable, connectors, Repeaters, Hubs, Bridges, Routers, Internet Applications, How the internet works. [Principles of Electronic Communication systems, Louis E Frenzel Jr.: 11-1, 11-2, 11-3, 11-4, 12-1, 12-2, 15-1]	25%
4.	**Satellite Communications** Satellite orbits, Satellite height, Satellite speed, Satellite period, Angle of inclination, Angle of elevation, Geosynchronous Orbits, Position Coordinates in Latitude and Longitude, Azimuth and Elevation, Satellite Communication Systems, Repeaters and Transponders, Frequency Allocations, Satellite Applications, Direct Broadcast Satellite (DBS), Satellite Cell Phones, Global Navigation Satellite Systems, Space Segment, Control Segment, GPS Receivers, GPS Applications. [Principles of Electronic Communication systems, Louis E Frenzel Jr.: 17-1, 17-2, 17-5, 17-6]	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: At the end of course, students will be expected to have learnt	
1.	Explain the basic concepts of electronic communication systems, including transmitter, receiver, and channel and classify types of communication systems.
2.	Compare AM, FM, and PM modulation techniques and their characteristics.
3.	Describe network types, topologies, and hardware components.
4.	Apply the knowledge of electronic communication systems to analyze and solve practical communication problems in analog, digital, and satellite domains.

Suggested References:

Sr. No.	References
1.	Principles of Electronic Communication systems, Louis E Frenzel Jr. (4th edition) Tata McGraw Hill Publications, New Delhi
2.	Electronic Communication: D. Roody and J. Coolen, Prentice Hall
3.	Electronic Communication Systems: F. R. Dungan, Delmar Publishers Inc.

Online resources to be used if available as reference material

Online Resources

https://nptel.ac.in/courses/117102059

https://www.youtube.com/watch?v=6nl-2GeQ8kQ

https://www.youtube.com/watch?v=WARM4fwsoT4&list=PLVsrfTSlZ_43SERuuAZZ-u1PBnwwn2ZfC

https://www.tutorialspoint.com/analog_communication/index.htm

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

Bachelor of Science B.Sc. Honours
Physics (Semester - VII)
(MODE-3: For B.Sc. Honours (with Course Work)

Course Code	US07HSEPHY01	Title of the Course	Integrated Circuit Fabrication Technology
Total Credits of the Course	2	Hours per Week	2
Course Objectives:	1. To describe the fundamentals of monolithic IC technology and planar processing techniques. 2. To analyze the role and construction of active and passive components in ICs. 3. To illustrate the fabrication procedures of semiconductor devices such as FETs. 4. To evaluate different IC fabrication techniques and their impact on circuit complexity, performance, and scalability.		

Course Content		
Unit	Description	Weightage* (%)
1.	**Integrated Circuit Fabrication-I** Introduction, Classification, IC Chip Size and Circuit Complexity, Fundamentals of Monolithic IC Technology, Basic Planar Processes, Silicon wafer preparation, Epitaxial growth, Oxidation, Photolithography, Diffusion, Ion implantation, Isolation techniques, Metallization, Assembly processing and packaging, Fabrication of a Typical Circuit [Linear Integrated Circuit, D. Roy Choudhary & Shail B. Jain: 1.1, 1.2, 1.3, 1.4, 1.5, 1.5.1, 1.5.2, 1.5.3, 1.5.4, 1.5.5, 1.5.6, 1.5.7, 1.5.8, 1.5.9, 1.6]	25%
2.	**Integrated Circuit Fabrication-II** Active and passive components of ICs, Monolithic transistors, Monolithic diodes, Integrated resistors, Integrated capacitors, Integrated inductors, Fabrication of FET, JFET fabrication, MOSFET fabrication, Complementary MOSFET (CMOS) fabrication, thick and thin film technology, Deposition of thin film, Thick-film technology, Surface mount technology, Technology trends. [Linear Integrated Circuit, D. Roy Choudhary & Shail B. Jain: 1.7, 1.7.1, 1.7.2, 1.7.3, 1.7.4, 1.7.5, 1.8, 1.8.1, 1.8.2, 1.8.3, 1.9, 1.9.1 1.9.2 1.9.3, 1.10]	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: At the end of course, students will be expected to have learnt	
1.	Explain the fundamentals of integrated circuit fabrication, including classification, chip size, and circuit complexity.
2.	Describe and apply the principles of monolithic IC technology and basic planar processes used in fabrication.
3.	Demonstrate the step-by-step fabrication process of a typical integrated circuit.
4.	Demonstrate the step-by-step fabrication process of a typical integrated circuit.

Suggested References:	
Sr. No.	References
1.	Linear Integrated Circuit, D. Roy Choudhary & Shail B. Jain (4th edition) New Age International Publishers
2.	Integrated circuits, K. R. Botkar Khanna Publishers
3.	Integrated Circuit Fabrication, James D. Plummer & Peter B. Griffin Cambridge University Press
4.	Integrated Electronics: Analog and digital circuits and systems, Jacob Millman & Christos Halkias, McGraw Hill

Online resources to be used if available as reference material
Online Resources
https://en.wikipedia.org/wiki/Integrated_circuit http://www.digimat.in/nptel/courses/video/108108111/L03.html https://www.youtube.com/watch?v=9QgdNsl9qwk http://www.digimat.in/nptel/courses/video/108108111/L07.html https://www.youtube.com/watch?v=6lJ2u7eYrek

Bachelor of Science B.Sc. Honours
Physics (Semester-VII)
(MODE-1: For B.Sc. Honours (with research)

Course Code	US07SEPHY01	Title of the Course	Research Project (RP)
Total Credits of the Course	6	Hours per Week	30

Course Objectives:	1. To introduce students to the fundamentals of scientific research, including literature survey, problem identification, and research methodology. 2. To develop analytical and experimental skills through independent investigation of a scientific problem related to the discipline. 3. To provide hands-on experience in data collection, analysis, and interpretation using appropriate scientific techniques. 4. To enhance scientific writing, presentation skills, and research ethics through preparation of a research project report.

Student Eligibility: Minimum CGPA of 7.5 or equivalent till the end of the 6th semester.

Students may undertake research work in areas related to their discipline under the guidance of a faculty member. The project should include:

- Selection of research topic
- Literature survey
- Objective of the study
- Research methodology / Experimental work
- Data collection and analysis
- Results and discussion
- Conclusion
- References / Bibliography

The component of marks: Internal Continuous Assessment (50%) and University Examination (50%).

Course Outcomes: Having completed this course, the learner will be able to	
1.	Identify and define a research problem through literature survey and scientific reasoning.
2.	Apply appropriate experimental or analytical methods to investigate the selected research problem.
3.	Analyze and interpret the obtained data and draw meaningful scientific conclusions.
4.	Prepare and present a scientific report demonstrating research skills, communication ability, and ethical practices.