GUJARAT UNIVERSITY

Revised Syllabus

To be implemented from Year 2024-2025

M. Sc (Physics)

SEMESTER – I

Course	Name of the Course	Lect. Hrs. / Week	Marks			Course Credits
			Internal	External	Total	
PHY-401	Quantum Mechanics & Mathematical Physics	4	30	70	100	4
PHY-402	Classical Mechanics-I & Statistical Mechanics	4	30	70	100	4
PHY-403	Nuclear Physics-I & Electrodynamics I	4	30	70	100	4
PHY-404	Solid State Physics & Analog Electronics	4	30	70	100	4
PHY-405 PR	Practicals	8	30	70	100	4
PHY-406 PT	Project	8	30	70	100	4
TOTAL		**32**	**180**	**420**	**600**	**24**

M. Sc (Physics) SEMESTER – I

PHY-401: Quantum Mechanics & Mathematical Physics

Learning Objectives:

- The study of Quantum Mechanics and Mathematical Physics help to understand almost all the modern branches of physics. Both are considered to be the language of physics. The syllabus is tuned with the topics of SET / CSIR-NET model syllabus.

Learning Outcomes:

- In two units of Quantum Mechanics, students will learn different methods for getting approximate solutions to solve the Schrodinger equation for some practical problems of atomic and molecular physics, leading towards research in the theoretical physics.
- Two units of Mathematical Physics, which not only enhance the skill of the young learners. The problem solving ability was given a special emphasis. After thzsorough learning of such topics, a student is expected to solve many body problems with advanced mathematical tools.

UNIT – I Approximation Methods for Stationary States & The Variation Method

Approximation Methods for Stationary States:

Perturbation theory for discrete levels, Equations in various orders of perturbation theory, Non - degenerate case, Degenerate case - removal of degeneracy, Effect of an electric field on the energy levels of an atom (Stark effect), Two – electron atoms. Illustrative examples.

The Variation Method:

Upper bound on ground state energy, Applications to excited states, Trial function linear in variational parameters, The Hydrogen molecule, Exchange interaction. Illustrative examples.

UNIT – II WKB Approximation & Evolution with Time:

One - dimensional Schrodinger equation, Bohr -Sommerfeld quantum condition, WKB solution of the radial wave equation.

Evolution with Time:

Exact formal solutions: Propagators, Schrodinger equation: general solution, Propagators, Alteration of Hamiltonian, transitions and sudden approximation. Illustrative examples.

UNIT – III Complex Variables:

Introduction, Analytical Function, Theorems, Illustrative examples, Contour Integral Theorem, Integral Formula Theorem, Illustrative examples, Laurent Series Theorem, Method of finding residues. The Residue Theorem, Evaluation of Definite, Integrals by use of the residue theorem, Examples, Additional illustrative examples.

UNIT – IV Group Theory and Tensors:

Group theory:

Group, subgroups and classes, Invariant sub groups, factor groups, Homomorphism and Isomorphism, Group representation, Reducible and irreducible representation, Representations of groups and quantum mechanics.

Tensor:

Introduction, superscripts and subscripts, Coordinate transformations, Indicial summation conventions, Dummy and Real indices, Kronecker delta symbol, Scalars, Contravariant vectors and covariant vectors, Tensors of higher ranks, Algebraic operations, Symmetric and Antisymmetric tensors, Invariant tensors, Conjugate and reciprocal tensors, Relative and absolute tensors, Line element and matrix tensor, Fundamental tensors.

Reference Books:

Unit I & II

1. P. M. Mathews and K. Venkatesan, A Text Book of Quantum Mechanics, 2nd Ed. TMH, New Delhi (2011).
2. V. K. Thankappan, Quantum Mechanics, 5th Ed., New Age International Pub., New Delhi (2020).
3. G. Aruldhas, Quantum Mechanics, 2nd Ed., PHI Learning Pvt. Ltd., Delhi (2017).
4. A. Ghatak and S. Loknathan, Quantum Mechanics, 6th Ed., Trinity Press, New Delhi (2019).
5. L. I. Schiff, Quantum Mechanics, 4th Ed., Tata McGraw Hill Edu., New Delhi (2017).
6. D. J. Griffiths and D. F. Schroeter, Introduction to Quantum Mechanics, 3rd Ed., Cambridge University Press India Pvt Ltd (2019).

E-Resources:

1. https://www.youtube.com/watch?v=pGerRhxNQJE
2. https://www.youtube.com/watch?v=zdouC7ZNTJ0
3. https://www.youtube.com/watch?v=SPs4xUXNhHE
4. https://youtu.be/myBFcyWA1rg
5. https://youtu.be/T4dMR6eHphg
6. https://www.youtube.com/watch?v=NOCnOZ9oOW0
7. https://www.youtube.com/watch?v=T-wXwgS7MuI
8. https://www.youtube.com/watch?v=Z5_wUKbAKC8
9. https://www.youtube.com/watch?v=7Y5me3mwXpA
10. https://youtu.be/bS-UqFnZPfA

Unit 3 & 4

1. M. L Boas, Mathematical Methods in the Physical Sciences, 3rd Ed., Wiley, USA (2005).
2. P. K. Chattopadhyaya, Mathematical Physics, 3rd Ed., New Age International Pvt. Ltd., New Delhi (2022).
3. G. B. Arfken and H. J. Weber, Mathematical Methods for Physicists, 6th Ed., Elsevier, USA (2005).
4. Satya Prakash, Mathematical Physics, 6th Ed., Sultan Chand & Sons, New Delhi (2020).
5. B. S. Rajput, Mathematical Physics, 28th Ed., Pragati Prakashan, Meerut (2015).
6. A. W. Joshi, Elements of Group Theory for Physicists, 4th Ed., New Age Int. Pub., New Delhi (2015).
7. A. W. Joshi, Matrices and Tensors in Physics, 4th Ed., New Age Int. Pub., New Delhi (2017).

E-Resources:

1. https://www.youtube.com/watch?v=VG54NFoupfk
2. https://www.youtube.com/watch?v=BOx8LRyr8mU
3. https://www.youtube.com/watch?v=nBbhKfHFkq8
4. https://www.youtube.com/watch?v=mhHdA9vsjSo
5. https://www.youtube.com/watch?v=nzmJb7KITxc
6. https://www.youtube.com/watch?v=TiHHz3sKDbY
7. https://www.youtube.com/watch?v=-iOcBqxTkx0

M. Sc (Physics) SEMESTER – I

PHY - 402: Classical Mechanics-I & Statistical Mechanics

Learning Objectives:

- The study of classical mechanics gives insight to understand some fundamental laws of physics in the classical domain. This gives basic understanding to develop such laws of physics in quantum physics.
- Statistical mechanics is a core course at the post graduate physics syllabus. The present syllabus is in continuation with undergraduate course and carries some of the advanced topics of the subject.
- The syllabus covers all the advanced topics of CSIR-NET model syllabus.

Learning Outcomes:

- Classical and Statistical Mechanics both are core courses of Physics.
- The concepts of canonical transformation and small oscillations are of fundamental importance and are expected to open up new horizons even for research problems.
- Under Statistical Mechanics course a detailed theories of time dependent and time independent fluctuations are covered.
- A complete theory of quantum phase transitions are exposed to the students.
- By learning this paper a student completes his advanced learning in Classical Mechanics and Statistical Mechanics.

Unit – I: Canonical Transformation:

Canonical transformation and Hamilton Jacobi theory: Gauge transformation, Canonical transformation, condition for transformations to be Canonical. Poisson bracket, canonical equations in terms of Poisson bracket notation, Relation between infinitesimal transformation and Poisson brackets, The Hamilton Jacobi equations, Separation of variables, Action angle variables, Properties of action angle.

Unit – II: Theory of Small Oscillations:

General case of coupled oscillations, Eigen vectors and eigen frequencies, orthogonality of eigen vectors, normal coordinates, small oscillations of particles on string.

Unit – III: Fluctuations:

Brownian motion, Langevin theory of random motion, Time dependence of fluctuations, Power spectrum of fluctuation, Persistence and correlation of fluctuation, Wiener-Khinching theorem, Johnson noise - Nyquist theorem, Shot noise.

Unit – IV: Critical Phenomena and Phase Transitions:

Phase transitions, Condition for phase equilibrium, First order phase transition, Clusius-Clayperon equation, Second order phase transition, The Critical exponent, Co-operative processes, Curie - Weiss theory of Magnetic transition, Ising Model, Ising Model in zeroth approximation, Exact solution of one dimensional Ising Model, Order parameters.

Reference Books:

Unit I & II

1. R. G. Takwale and P. S. Puranik, Introduction to Classical Mechanics, 55th Ed., TMH, New Delhi (2016).
2. H. Goldstein, C. P. Poole, J. L. Safko, Classical Mechanics, 3rd Ed., Pearson India, New Delhi (2011).
3. V. B. Bhatia, Classical Mechanics Classical Mechanics: With Introduction to Nonlinear Oscillations and Chaos, Narosa Pub. House, New Delhi (2001).
4. J. C. Upadhyay, Classical Mechanics, Himalaya Publishing House, Mumbai (2016).

5. G. Aruldhas, Classical Mechanics, 8th Ed., PHI Learning Private Limited, New Delhi (2017).

E-Resources:

1. https://ocw.mit.edu/courses/8-09-classical-mechanics-iii-fall-2014/f00f7f68ac7ba346a0868efb7430582c_MIT8_09F14_Chapter_4.pdf
2. https://youtu.be/pt28ZeliXhI
3. https://youtu.be/52r6EJJ29ag
4. https://youtu.be/uhLImoW5B8E
5. https://youtu.be/EgS4deid37g
6. https://youtu.be/8Ph2SFVoO04
7. https://youtu.be/mdBybtnBq3o
8. https://youtu.be/TZmF6doPQjg
9. https://youtu.be/w3var176Eg8
10. https://www.youtube.com/watch?v=D-jQmPmyRYA
11. https://youtu.be/DDaTQlIIcGA
12. https://youtu.be/diwpC-A5qls
13. https://youtu.be/1oGqlLLS35w
14. https://youtu.be/Cif65OWT1cA
15. https://www.youtube.com/watch?v=XEPC8nQsiH8
16. https://www.youtube.com/watch?v=dwxIT4wn6EE
17. https://www.youtube.com/watch?v=ghunAzQ4JPs

Unit III & IV

1. S. K. Sinha, Statistical Mechanics - Theory and Applications, Narosa Pub House, New Delhi (2005).
2. E. S. Raja Gopal, Statistical Mechanics and Properties of Matter, McMillan Co. Limited (1974).
3. E. Guha, Statistical Mechanics - An Introduction, Narosa Publishing House, New Delhi (2008).
4. R. K. Patharia, Statistical Mechanics, Pergamon Press
5. F. Reif, Fundamentals of Statistical Mechanics, 2nd Ed., Butterworth-Heinemann, Oxford (2001).
6. R. K. Srivastava and J. Ashokan, Statistical Mechanics, Printice Hall of India, New Delhi (2005).
7. J. D. Walecka, Fundamentals of Statistical Mechanics, World Scientific, US (2000).
8. L. D. Landau and E. M. Lifshitz, Landau Theory of Phase Transition in Statistical Physics, Vol. 5, 3rd Ed., Science Direct, Elsevier B.V., Netherlands (1980).

E-Resources:

1. https://www.youtube.com/watch?v=iud7fzXPJUs
2. https://www.youtube.com/watch?v=J7Df_td7gCc
3. https://www.youtube.com/watch?v=PF7sDT9C-5Y
4. https://www.youtube.com/watch?v=VBaah8drgVA
5. https://www.youtube.com/watch?v=bdnYEB3ByO8
6. https://www.youtube.com/watch?v=WWhMjbDcC6A
7. https://youtu.be/7WGiH-AKUqI?si=4sBp9Zt_TtgeYinC
8. https://www.youtube.com/watch?v=ancLYSF07C8
9. https://www.youtube.com/watch?v=1XBKV1pU-mA
10. https://www.youtube.com/watch?v=9R0tR6DC6Z0

M. Sc (Physics) SEMESTER – I

PHY – 403: Nuclear Physics – I & Electrodynamics - I

Learning Objectives:

- To make students to understand the nuclear properties like electric moments, magnetic moments etc . and the two body problems of deuteron.
- Electrodynamics is one of the core-subjects to teach electromagnetism conceptually. This course on Electrodynamics offers basic principles, complex derivatives, and fundamental of theoretical concepts.
- Primary objectives of this course are to make the students understand basic concept of electrodynamics and gain knowledge of Electromagnetic wave nature.

Learning Outcomes:

- Students will have understanding of atomic spectra, hyperfine structure and low energy of nucleons interactions.
- By studying these topics students will have conceptual understanding of the wave propagation, Maxwell's equations in media, Electromagnetic energy densities and Pointing's theorem, Reflection and Refraction of electromagnetic waves inside the perfect conductor and dielectric media, Power loss in a plane conductor etc.
- By studying the Transmission Lines theory, students will be able to do analysis transmission lines. Students will be able to solve transmission line problems using standard transmission line equations as well as Smith chart.

Unit – I: Nuclear Properties:

Nuclear Size, Nuclear radii, Nuclear Parity, Isotopic Spin, Nuclear spin, Electric moments, Magnetic moments, A brief description of hyperfine structure of atomic spectra, effect of an external magnetic field on the hyperfine structure, determination of I from molecular band spectra, Molecular beam resonance method – experiments on hydrogen and deuteron.

Unit – II: Two Body Forces:

Deuteron: ground state and excited states of deuteron, n-p scattering at low energies, scattering length, spin dependence of n-p scattering, singlet state of n-p scattering, effective range theory of n-p scattering, p-p scattering at low energy, exchange forces, Meson theory of nuclear forces, Tensor forces.

Unit – III: Electromagnetic waves in Matter:

Propagation in linear media, Uniform plane waves propagation, Conductors and Dielectrics, Reflection and transmission of plane waves at normal incidence, Reflection and transmission at oblique incidence, Surface impedance, Total internal reflection, Reflection from the surface of a metal, Pointing's theorem, Instantaneous, Average and complex Pointing vector, Power loss in a plane conductor, Illustrative examples.

Unit – IV: Waveguides and Transmission Line:

Transmission Lines:

Transmission Lines, Circuit representation of the parallel transmission line, Parallel planes transmission lines with loss, E and H about long parallel cylindrical conductors of arbitrary cross-section, Transmission Lines theory, Low-loss Radio Frequency and UHF Transmission Lines , UHF lines as circuit elements, Transmission Lines charts, Illustrative examples.

Reference Books:

Unit I & II

1. H. A. Enge, Introduction to Nuclear Physics, Addison-Wesley Publishing Company (1966).
2. R. R. Roy and B. P. Nigam, Nuclear Physics Theory and Experiments, 2nd Ed., New Age International Pvt. Ltd. New Delhi (2014).

3. D. C Tayal, Nuclear Physics, Himalaya Publishing House, Mumbai (2011).
4. S. B. Patel, Nuclear Physics: An Introduction, New Age Int. Pub., New Delhi (2021).
5. J. Singh, Fundamentals of Nuclear Physics, Pragati Prakashan, Meerut (2021).
6. K. S. Krane, Introductory Nuclear Physics, John Wlley & Sons, New York (1988).

E-Resources:

1. https://www.youtube.com/watch?v=9cyDFNPPOYU
2. https://www.youtube.com/watch?v=josqjcH79PE
3. https://www.youtube.com/watch?v=6LoWEs8z1A4
4. https://youtu.be/6LoWEs8z1A4?si=NSmiOvXpMkvAw5Y6
5. https://youtu.be/qXi246lq6Rs?si=SJQAjYEpErIumFar
6. https://youtu.be/4ivtgtanGpc?si=lDgonvUl8y_yMYt-
7. https://youtu.be/K_my_6jR8Ck?si=bMafj0kcWR9zoLb8
8. https://www.youtube.com/watch?v=55s1olpu7h8
9. https://youtu.be/Jf6MSWoZRmc?si=s_lESHUx6SZpw-dn
10. https://youtu.be/5KOJLxcaQto

Unit III & IV

1. J. Griffiths, Introduction to electrodynamics, Prentice Hall India Ltd. (2nd ed.)
2. B.B. Laud, Electromagnetics, Wiley Eastern, (2nd ed.)
3. E. C. Jordan and K. G. Balmain, Electromagnetic waves and radiating systems, Prentice Hall of India, New Delhi, 1976

E-Resources:

1. https://youtu.be/uC1W_1eyjPk
2. https://youtu.be/2dHBUByjmrs
3. https://youtu.be/mN0zyefCKfY
4. https://youtu.be/13Ei1DZlxIE
5. https://youtu.be/7RKj14m9wEI
6. https://youtu.be/IsPbg_F1DXk
7. https://youtu.be/ihGgXcaUcZU
8. https://youtu.be/_nL6a21q1a4
9. https://youtu.be/BdR3mvvqFuQ
10. https://youtu.be/7-D-WvYz9J8
11. https://youtu.be/BdR3mvvqFuQ
12. https://youtu.be/YfM3iG0Jsxg
13. https://youtu.be/5TdTAJeVbmM
14. https://youtu.be/iaSrm2u6J-k
15. https://youtu.be/-xOq-WxXOgg
16. https://youtu.be/fh2MLGVtb0U
17. https://youtu.be/TgEeJ1ZZDeM
18. https://youtu.be/8TaXF6dfurM
19. https://youtu.be/9WUDdTebEDY
20. https://youtu.be/0PI82Z7exIs
21. https://youtu.be/fh2MLGVtb0U
22. https://youtu.be/KQHGN6WjZqI
23. https://youtu.be/yezmCNGTVYU
24. https://youtu.be/HtoAbUqg_hM?list=PLdFco-rRUDt1pMTtPkI2lYq1X1NNjbKwg
25. https://youtu.be/jPgN0--6AGA

26. https://youtu.be/364mZxZnOsU
27. https://youtu.be/vskns2KRUT4
28. https://youtu.be/-aEgAIwfoX4
29. https://youtu.be/kz8-TTpZjHI?list=PLFxhgwM1F4yz620k0WcHdRrO5JRAC0yFh
30. https://youtu.be/XrauyYbrTfg
31. https://youtu.be/W6fLtTxgFkk
32. https://youtu.be/NrU5X2ZFkjQ
33. https://youtu.be/ahKy0vmt_4s
34. https://youtu.be/smwDwfBoDUY
35. https://youtu.be/VzGnb2K4RGQ
36. https://youtu.be/eUpK0fQP2Ms
37. https://youtu.be/6ZdXP4ABtaQ
38. https://youtu.be/PHNjH653OcQ
39. https://youtu.be/gpitMTcDDmo
40. https://youtu.be/9rLC6EFe6VM
41. https://youtu.be/Nn7_3lHhtpI
42. https://youtu.be/-4cUv92FCqM
43. https://youtu.be/30_RGcjvNKI

M. Sc (Physics) SEMESTER – I

PHY – 404: Solid State Physics & Analog Electronics

Learning Objectives:

- To study Electronic Energy bands in crystalline solids.
- To study methods of calculating energy bands in crystalline solids.
- To learn various zone schemes.
- To study Harrison Construction of Fermi surface.
- To understand Quantization of Orbits in magnetic field.
- To understand concept of Occurrence and Destruction of superconductivity.
- To study Meissner effects.
- To study London penetration depth and coherence length in a superconductor.
- To study how superconductors are classified as Type-I and Type-II superconductors.
- To study BCS Theory.
- To study pair tunnelling, DC and AC Josephson effects; and Macroscopic quantum interference.
- To be familiarized with the extremely versatile voltage regulated IC 723.
- To understand block diagram and working of voltage regulated IC 723.
- Learn to design variable voltage regulated power supply using IC 723.
- To know about the types of the large signal (power) amplifiers, their merits and demerits.
- To learn to analyze the large signal amplifiers.
- To study in detail about the various linear applications of the operational amplifier.

Learning Outcomes:

- Students will be able know classification of solids based on the energy gap.
- Students will be able to calculate Electronic Energy bands in crystalline solids.
- Students will be able to know concept of Fermi Surface and its importance.
- Students will be able to understand and able to draw various zone schemes.
- Students will be able to understand Quantization of Orbits in magnetic field and de Has-van Alphen effect.
- Students will learn concept of Occurrence and Destruction of superconductivity.
- Students will understand diamagnetic nature of superconductor, Meissner effects, London penetration depth and coherence length in a superconductor.
- Students will be able to know classification of superconductors as Type-I and Type-II superconductors.
- Concept of BCS Theory will be developed in the minds of students.
- Students will be able to know pair tunnelling, DC and AC Josephson effects; and Macroscopic quantum interference.
- Students will be able to design and develop variable voltage regulators using IC 723 and other similar ICs.
- Understand working of the IC 723 and interpret technical specifications of IC.
- Differentiate between small and large signal amplifiers.
- Analyse and design power amplifiers.
- Analyse OPAMP based circuits.
- Solve problems of the OPAMP based circuits.

Unit – I: Energy Bands and Fermi Surfaces

Energy Bands:

Introduction, Nearly Free Electron model, Origin of the energy gap, Magnitude of the energy gap, Bloch functions, The Kroning-Penney model, Wave Equation of electron in a periodic potential, Crystal momentum of an electron, Solution of the central equation, Empty lattice approximation, Approximate solution near a zone boundary, Number of orbitals in a band.

Fermi Surfaces and Metals:

Introduction, Periodic zone scheme, Extended zone scheme, Reduced zone scheme, Construction of Fermi surfaces, electron orbits, hole orbits and open orbits, Calculations of energy bands, Tight binding method for energy bands, Experimental methods in Fermi Surface studies, Quantization of orbits in a magnetic field, de - Haas - Van Alphen Effect.

Unit – II: Superconductivity

Introduction, Occurrence of superconductivity, Destruction of superconductivity of magnetic field, Meissner effect, Heat Capacity, Energy gap, Isotope effect, Thermodynamics of the superconducting transition, London equation, Coherence Length, BCS theory of superconductivity, BCS ground state, Flux quantization in a superconducting ring, Duration of persistence current, Type-I and Type-II superconductors, Vortex state, Estimation of Hc1 and Hc2, Single particle tunnelling, Josephson superconductor tunnelling, DC Josephson effect, AC Josephson effect, Macroscopic quantum interference, Introduction to High Tc Superconductors, Problem Solving.

Unit – III: Voltage Regulators & Power Amplifiers

Voltage Regulators:

IC Regulators using 723, Positive, Negative, Low and High voltage regulators, current booster transistor, fold back current limiting circuit.

Power Amplifiers:

Class - A large signal amplifiers, transformer coupled Class - A amplifier, second harmonic distortion, push - pull Class - A amplifier, Class - B Push - Pull amplifiers.

Unit – IV: The Operational Amplifier & Applications

Frequency compensation and slew rate, DC and AC amplifiers, Integrator and differentiator, Voltage to current and current to voltage converter, Bridge amplifier, Electronic analogue computation, sine, square, triangular and saw tooth wave generators, Comparators, Schmitt trigger, Active filters: low pass, high pass, band pass, band reject, notch.

Reference Books:

Unit I & II

1. C. Kittle, Introduction to Solid State Physics, 8th Ed., Wiley Eastern Limited, New Delhi (2018).
2. J. P. Srivastava, Elements of Solid State Physics, 4th Ed., PHI Learning Private Limited, Delhi (2016).
3. C. M. Kachhava, Solid State Physics, Solid State Devices and Electronics, New Age International Publishers, New Delhi (2011).
4. S. O. Pillai, Solid State Physics, 10th Ed. New Age International Publishers, New Delhi (2023).
5. S. L. Kakani and C. Hemrajani, Solid State Physics – Theory, Applications and Problems, Sultan Chand and Sons, New Delhi (2014).
6. B. S. Saxena, P. N. Saxena, R. C. Gupta and J. N. Mandal Fundamentals of Solid State Physics, 32nd Ed., Pragati Prakashan, Meerut (2022).
7. A. K. Saxena, Solid State Physics (With an Introduction to Semiconductor Devices), 3rd Ed., Trinity Press, New Delhi (2014).

E-Resources:

1. https://youtu.be/qcE2Wcpm05k?si=znmHaCYVeUzTB_L6
2. https://youtu.be/_5YeWWQ43_M?si=i1db9rFdvtewIMv7
3. https://youtu.be/tdo_cqP_JnE?si=h1aGOJmQQTHpjNZG

4. https://youtu.be/BlYJzUA6pGA?si=7V7AJW3_A-XSUDJL
5. https://youtu.be/TmdLQuyzNzM
6. https://youtu.be/ZemvjQdLffo
7. https://youtu.be/PW_pVqlcBPg?si=OKtaFZLpX3eOXQqW
8. https://youtu.be/fnMoQurFhSs?si=mTKc3IdR8ekg6gam
9. https://youtu.be/fnMoQurFhSs?si=qMgAPqRWtwZeoqnG
10. https://youtu.be/SHoGV-sezNI
11. https://youtu.be/D-9M3GWoBrw?si=W_xpHVwwdQK5ff13

Unit III & IV

1. K. R. Botkar, Integrated Circuits, 10th Ed., Khanna Publishers, New Delhi (1987).
2. R. Boylested and L. Nashelsky, Electronic Devices and Circuit Theory, 4th Ed., Longman Higher Education, New Delhi (1987).
3. J. D. Ryder, Electronic Fundamentals and Applications : Integrated and Discrete Systems, 5th Ed., PHI, New Delhi (1975).
4. A. Mottershead, Electronic Devices and Circuits: An Introduction PHI, New Delhi (1979).
5. K. V. Ramanan, Functional Electronics, Tata McGraw-Hill, New Delhi (1984).
6. R. Gayakwad, OPAMP & Linear Integrated Circuits, 3rd Ed., PHI, New Delhi (1993).

E-Resources:

1. IC 723 Voltage Regulator - Working, Application Circuit - Homemade Circuit Projects (homemade-circuits.com)
2. https://youtu.be/3l_9NEh4Nz8?si=o4Z7XnLs0atQnh_L
3. https://youtu.be/2GijhTUQTbw?si=u5ImJ5Vu3AtklhUz
4. https://youtu.be/hzGRkhscQ9k?si=WpHMjzO8P25PJrWm
5. https://youtu.be/WklUVqD8RXs
6. https://youtu.be/SaJsL9_M1_w
7. https://youtu.be/W70GFpfILKk

M. Sc (Physics) SEMESTER – I

PHY– 405 PR : PRACTICALS

Learning Objectives:

To be familiarize with 741 and 723 ICs operation and their applications

To learn about the operation of GM counter and Ultrasonic interferometer

To study electronic bands of crystalline solids.

Learning Outcomes:

Students will be able to Design and test various electronic circuits using 741 and 723 ICs.

Demonstrate the functioning of various scientific instruments.

Sr.No.	Title of the Practical
1	Ultrasonic Interferometer
2	Phonon dispersion relation using Lattice dynamics kit
3	Efficiency of a G.M. Counter
4	Calculation of Empty Lattice Energy Bands
5	Random walk problem
6	SCR Characteristic
7	Dielectric constant of liquid.
8	OPAMP IC 741: parameters
9	OPAMP IC 741: Adder, Subtractor, Integrator and differentiator
10	Design and Study of Astable Multivibrator using IC 741
11	Design and Study of Phase Shift Oscillator using IC 741
12	Design and Study of Voltage Regulated Power Supply using IC 723
13	Design and Study of Schmitt Trigger using IC 741.
14	Design and Study of Low/high pass filter Circuit using IC 741.
15	OPAMP: inverting / non-inverting amplifier

15% of new experiments can be introduced AND / OR replaced as per the need, with the permission of the Chairman of Board of studies.

M. Sc (Physics) SEMESTER – I

PHY - 406 PT : POJECT

- In-house project work of 4-credit to be performed by each student.
- Alternatively, MOOC, Swayam or any other UGC recognized online course in Physics of at least 03 weeks duration and equivalent to 4 credits will also be considered for 4-credit in this course.
- Every student shall work on a project under a faculty member of the department.
- Project work may be carried out within the department or in other department, or from other institution (if required).
- Allotment of the supervisors shall be done by the Department.
- The supervisor shall act as the instructor for this course on project and make continuous assessment based on the understanding/ literature survey, experimental/ theoretical formulation, performance, interpretation of results and writing of Report.
- End-semester evaluation will be based on evaluation of report, presentation and viva voce examination of the candidate at the end of the semester by a panel of examiners.

GUJARAT UNIVERSITY

Revised Syllabus

To be implemented from Year 2024-2025

M. Sc. (Physics)

SEMESTER – II

Course	Name of the Course	Lect. Hrs. / Week	Marks			Course Credits
			Internal	External	Total	
PHY - 407	Digital Electronics & Microprocessor – I	4	30	70	100	4
PHY - 408	Numerical Techniques & Electrodynamics – II	4	30	70	100	4
PHY - 409	Semiconductor Physics & Devices	4	30	70	100	4
PHY - 410	Solid State Properties & Electronic Communications	4	30	70	100	4
PHY - 411 PR	Practicals	8	30	70	100	4
PHY - 412 PT	Project	8	30	70	100	4
TOTAL		**32**	**180**	**420**	**600**	**24**

M. Sc. (Physics) SEMESTER – II

PHY – 407: Digital Eletronics & Microprocessor – I

Learning Objectives:

- Digital electronics is a very important area of electronics. Digital circuits, memories, clocks, timers and counters are taught in detail. ADC and DAC techniques for digitization of signals are included.
- Microprocessor – I course covers an architecture, instruction sets including classification, buses, machine cycles, writing and executing of simple programs as well as pin and functional block diagrams of 8-bit 8085 Microprocessor. This course also includes some details of Microcomputer systems along with logic devices, and memory interfacing. Students can get some information about ASCII, and BCD codes.

Learning Outcomes:

- In unit I, the students will learn the working of parity generators, clock and timer circuits, shift registers and counters which are the basic blocks for the working of microprocessor and microcontroller circuits.
- In unit II, the students will learn the working of different types of D/A and A/D convertors which are the basic blocks for the peripherals attached with the microprocessor and microcontroller circuits.
- Microprocessor is the basic block of modern computers. Architecture, instruction sets and writing of simple programmes enable students to develop machine language algorithms and codes.

Unit – I: Digital Electronics:

Parity generators and checkers, read only memory, programmable array logic.

Clocks & Timers: Clock waveform, TTL clock, 555 Timer (internal block diagram) as Monostable Multivibrator and as Astable Multivibrator.

Shift Registers: Types of registers, serial in - serial out, serial in - parallel out, parallel in - serial out, parallel in - parallel out, ring counter.

Counters: Concept of asynchronous counters (IC 7493 Binary counter, IC 7490 Decade counter), Concept of synchronous counters (IC 74193-4-bit up-down counter) Digital clock

Unit – II : D/A and A/D Conversion:

Variable register network, Binary ladder, D/A converter, D/A accuracy and resolution, A/D converter - simultaneous conversion, counter method, continuous A/D conversion, A/D techniques, Dual slope A/D conversion, A/D accuracy and resolution, application of DAC & ADC.

Unit – III : Microprocessor based Systems:

Microprocessors, Microcomputers and Assembly language, Introduction to 8085 Assembly language programming, Microprocessor Architecture and Microcomputer system.

Logic devices for interfacing: Tri-state devices, Buffer, Examples of Tri-state buffer. Bidirectional buffer, octal buffer, Logic diagram and Function Table, Decoder, (2 to 4), (3 to 8), Examples of Decoders, Encoder (8 to3), D-Flip-Flops: Latch and clocked; Examples of Latches (Registers), Logic diagram and Function Table.

The 8085 Microprocessor: pin diagram and signals. Demultiplexing the bus AD7-AD0 Functional block diagram, 8085 single-board microcomputer system

Unit – IV: Microprocessor Architecture:

Introduction to 8085 instructions: Data transfer (copy) operations, Arithmetic and logical operations, Branch operations and Machine control operations. Writing Assembly language programs.

Programming Techniques with Additional Instructions:

Programming Techniques: Looping, Counting and Indexing, conditional loop, counter, 16-bit Arithmetic instructions, 16-bit data transfer to Registers pairs (LXI), Arithmetic operations related to 16-bits (Register Pairs), Logic operations: Rotate, Applications of Rotate instructions, Illustrative program: Checking sign with Rotate instructions,

Counters and Time delay: Counter, Time delay- using one Register, a Register pair, a loop within loop technique, Delay calculations, Additional techniques, Counter design with time delay, Hexadecimal zero to nine (Modulo ten_ Counters, Illustrative program: Generating pulse wave forms, Debugging counter and time delay programs.

Stack and Subroutine: Concepts of Stack and Subroutine, Examples, Illustrative programs: Resetting and displaying flags, Traffic Signal Controller, Multiple calling of a subroutine Restart, Conditional call and Return instructions, Advance subroutine concepts: Nesting, Multiple ending subroutines, Similarities and differences between CALL-RET, PUSH-POP instructions.

BCD: Addition, subtraction, multiplication.

Reference Books:

Unit I & II

1. A. P. Malvino, D. P. Leach and G. Saha, Digital Principles and Applications, 8th Ed., Tata McGraw-Hill Publishing Company Limited, New Delhi (2014).
2. A. Kumar, Fundamentals of Digital Circuits, 4th Ed., PHI Private Limited, New Delhi (2016).
3. M. Morris Mano, Digital Logic and Computer Design, PHI Private Limited, New Delhi (2006).
4. A. K. Maini, Digital Electronics Principles, Devices and Applications, 1st Ed., John Wiley & Sons Ltd, England (2007).

E-Resources:

1. https://www.youtube.com/watch?v=CeD2L6KbtVM
2. https://www.youtube.com/watch?v=BqP6sVYlrr0
3. https://www.youtube.com/watch?v=sUutDs7FFeA
4. https://youtu.be/oNh6V91zdPY
5. https://youtu.be/lw21I8VBTrQ
6. https://youtu.be/ApILP5WPZeE
7. https://www.youtube.com/watch?v=TirvWsbqBUc
8. https://www.youtube.com/watch?v=xdoAB7jevk0

Unit III & IV

1. R. S. Gaonkar, Microprocessor Architecture, Programming and Applications with 8085, 6th Ed., Penram International Publishing India Private LTD, Mumbai (2016).
2. A. K. Mukhopadhaya, Microprocessor, Microcomputer & their Applications, 2nd Ed., Narosa Publisher, New Delhi (2001).
3. B. Ram, Fundamentals of Microprocessors & Microcomputers, Dhanpat Rai Publications, New Delhi (2018).
4. A. Wadhawa, Microprocessor 8085, Architecture, Programming and Interfacing, 3rd Ed., PHI, New Delhi (2013).

E-Resources:

1. https://youtu.be/bF54YIwZGB4
2. https://youtu.be/MqWeH3zp5GY
3. https://youtu.be/cH5Sk9-BzeE

M. Sc. (Physics) SEMESTER – II

PHY – 408: Numerical Techniques & Electrodynamics – II

Learning Objectives:

- To deduce empirical laws from a set of observations.
- To fit a curve to set of observations.
- To obtain unknowns for an empirical relation.
- To understand Consistency of a system of linear simultaneous equations.
- To determine the unknown variables involved in a system of linear simultaneous equations.
- To learn direct and iterative method of solutions.
- To learn about ill-conditioned system and its solution.
- To make students understand basic principles, complex derivatives, and fundamental theoretical concepts of Scattering and dispersion.
- To make students learn the concept of Scattering of radiation by a free charge and bound charge.
- To learn dispersion in gases, liquids and solids.
- To understand the concept of Radiation from moving charges.
- To understand the concept of Plasma physics.
- To learn fluid model and Collisions.
- To understand the Coulomb barrier.

Learning Outcomes:

- From a given set of observations, students will be able to predict an empirical relation.
- Students will be able to fit given set of observations to a best fit curve
- Students will be able to convert various forms of non-linear equations having two or three unknowns in to a linear equation of two variables.
- Students will be able to calculate best value of knowns for a given set of observations and an empirical relation.
- Students will be understanding the concept of simultaneous equations, distinguish between homogeneous and non-homogeneous equations.
- Students will be understanding various ways to solve a set of simultaneous linear algebraic equations.
- Students will be able to solve a set of simultaneous linear algebraic equations.
- Students will be able to know ill-conditioning of a set of simultaneous linear algebraic equations.
- Students will be able to solve ill-conditioned set of simultaneous linear algebraic equations.
- Students will be able to understand the Scattering of radiation by a free charge and bound charge.
- Students will be able to understand the dispersion behaviour in gases, liquids and solids.
- Students will be able to understand the Heating and confinement of the plasma
- Students will know about Plasma propulsion and Other plasma devices

Unit – I: Empirical Laws and Curve Fitting:

Introduction, Graphical method, Laws reducible to the linear law, Method of group averages, Laws containing three constants, Principle of least squares, Method of least squares, Fitting of other curves, Method of moments.

Unit – II: Solution of Simultaneous Algebraic Equation:

Consistency of a system of linear equations, System of linear homogeneous equations, Solution of linear simultaneous equations, Matrix inversion method, Gauss elimination method, Gauss-Jordan method, Factorization method.

Jacobi's iterative method, Gauss-Seidal iterative method, Relaxation method, Ill-conditioned equation, Iterative method to improve accuracy of an ill-conditioned system, Solution of non-linear simultaneous equations by Newton-Raphson method.

Unit – III: Scattering and Dispersion:

Scattering of radiation by a free charge, Scattering of radiation by a bound charge, Radiation damping, Dispersion in dilute gases, Dispersion in liquids and solids. Frequency dependence ε, μ, σ. Dispersion in non-conductors, Free electrons in conductors and Plasma, Illustrative Examples.
Dynamics of charged particles in static and uniform EM fields, Radiation from moving charges, dipoles and retarded potentials

Unit – IV: Plasma:

The moment equations, Derivation of the moment equations, Magneto-hydrodynamic OR MHD, One fluid model, Two fluid model, Collisions, Liouville equation, The system of B.B.G.K.Y. Equations, The B-V equation with self-consistent field, Controlled thermonuclear reaction, Lawson criterion, The Coulomb barrier, Heating and confinement of the plasma, Radiation loss of energy, Instability problem, Magneto-hydrodynamic conversion of energy, Plasma propulsion, Other plasma devices, Illustrative Examples.

Reference Books:

Unit 1 & 2

1. S. Grewal and J. S. Grewal, Numerical Methods in Engineering and Science, Khanna Publishers, New Delhi (2002).
2. E. Balgurusamy, Numerical Methods, TMH Pub. Co. Ltd, New Delhi (2000).
3. R. Srivastava and S. Guha, Numerical Methods: for Engineering and Science, OUP India (2010).
4. S. C. Chapra and R. P. Canale, Numerical Methods for Engineers, 8th Ed., TMH, India (2021).
5. A. Gilat and V. Subramaniam, Numerical Methods for Engineers and Scientists An Introduction with Applications using MATLAB, 3rd Ed., Wiley, USA (2014).

E-Resources:

1. https://www.youtube.com/watch?v=3Hp-TwOBWAs
2. https://www.youtube.com/watch?v=i6ZmA9EEzrI
3. https://www.youtube.com/watch?v=nBY2K7CLX-M
4. https://www.youtube.com/watch?v=j6L0yRHf5aU
5. https://www.youtube.com/watch?v=ib6pJdAfuIQ
6. https://www.youtube.com/watch?v=_FRGvpeYLSk

Unit 3 & 4

1. E. C. Jordan and K. G. Balmain, Electromagnetic Waves and Radiating Systems, 2nd Ed., PHI, New Delhi (1976).
2. B. B. Laud, Electromagnetics, 4th Ed., New Age International Pvt. Ltd., New Delhi (2022).
3. J. Griffiths, Introduction to Electrodynamics, 4th Ed., Pearson Education India Learning Pvt. Ltd., New Delhi (2015).
4. S. N. Goswami, Elements of Plasma Physics, New Central Book Agency Pvt. Ltd, Calcutta (2011).
5. F. F. Chen, Introduction to Plasma Physics, Plenum Press, US (2006).
6. F. F. Chen, Introduction to Plasma Physics and Controlled Fusion, 3rd. Ed., Springer, Switzerland (2016).

E-Resources:

1. https://youtu.be/xCcM4wB03B0
2. https://youtu.be/OKUjqGPT4lc
3. https://youtu.be/Q8tJP2xdWlQ

4. https://youtu.be/puavV2P6518
5. https://youtu.be/nyCxODx-zY0
6. https://youtu.be/66OAWxHC44s
7. https://youtu.be/u8-t4D2mekI?list=PLgMDNELGJ1CbELVC__61OPlqSe6tQn6En)
8. https://youtu.be/L-eOdZFt9BY
9. https://youtu.be/G2zgAs5O7I8
10. https://youtu.be/AXDseVTQkbc
11. https://youtu.be/l4xm-wqdwM8
12. https://youtu.be/OquQix3csrY
13. https://www.youtube.com/watch?v=fa0zHI6nLUo&list=PLbMVogVj5nJTZJHsH6uLCO00I-ffGyBEm
14. https://www.youtube.com/watch?v=lJSUeEqGNY0&list=PLwdnzlV3ogoV-ATGY2ptuLS9mwLFOJoDw

M. Sc. (Physics) SEMESTER – II

PHY – 409 : Semiconductor Physics & Devices

Learning Objectives:

- Proposed syllabus includes several fundamental and advanced topics of semiconductor physics.
- The syllabus is complementary to solid state physics and condensed matter physics.
- To understand construction and working principle of MOSFET and learn to use them as circuit element.
- Students will be introduced with the different IC logic families with emphases to TTL and CMOS ICs.

Learning Outcomes:

- Students will be learning fundamentals and modern concepts of semiconductor physics, which are very much important for device fabrication applications.
- Students do perform projects which are complementary to theory.
- Students can classify the TTL IC and MOS ICs.
- Students will be able to use TTL IC and MOS ICs in various electronic circuits.
- Also they can understand optoelectronic Device characteristics.

Unit – I : Energy Bands and Carrier Concentration in Thermal Equilibrium:

Energy Bands; Energy levels of isolated atoms, Energy momentum Diagram, Direct and Indirect band gap semiconductors; band diagrams of metals, semiconductors and insulators, Intrinsic carrier concentration, Concept of Fermi factor, Extrinsic semiconductors : Donors and Acceptors, Nondegenerate and Degenerate semiconductors, Carrier Drift : Mobility and its relation with resistivity and conductivity, The Hall effect.

Unit – II : p-n Junction:

Band Diagram of p-n junction in thermal equilibrium; Equilibrium Fermi levels; Space Charge; Depletion region, Abrupt junction; Widths of the depletion region in abrupt junction; Depletion capacitance; Capacitance-voltage characteristics; Current voltage characteristics; Ideal diode equation.

Unit – III : MOSFETs & Optoelectronic Devices:

MOSFET:

Depletion and Enhancement MOSFET, Difference between JFET and MOSFET, Handling precaution for MOSFET,

OPTOELECTRONIC DEVICES: LED: Introduction, Radiative transitions, Emission spectra, Methods of excitations, LED structures, Choice of Materials, Definition of efficiencies, Semiconductor LASER: Semiconductor Laser structures and materials, Advantages of Laser

Detectors: Introduction, Photoconductor, Photodiodes, p-i-n and p-n photodiodes, Avalanche photodiode, Phototransistor, Photovoltaic effect and solar cell.

Unit – IV : Digital Integrated Circuits:

Introduction, level of integration, Digital IC families, TTL logic family: Introduction, NAND gate with Totem-pole output, Types of TTL, TTL parameters-floating inputs, worst-case input/output voltages, profile and windows, compatibility, sourcing and sinking, Three state TTL devices.

MOS-Logic family: Introduction, MOS Inverters, NMOS-NAND and NOR gates, CMOS logic family: NAND and NOR gates, Power dissipation, CMOS characteristics- floating inputs, compatibility, sourcing and sinking, TTL to CMOS and CMOS to TTL interface.

Reference Books:

Unit I & II

1. S. M. Sze, Semiconductor Devices: Physics and Technology, 3rd Ed., Wiley, India (2016).
2. S. M. Sze and K. K. Ng, Physics of Semiconductor Devices, 4th Ed., John Wiley & Sons, India (2006).
3. D. Nauman, Semiconductor Physics and Devices: Basic Principle, 4th Ed. TMH, New Delhi (2011).
4. B. G. Streetman and S. Banerjee, Solid State Electronic Devices, 7th Ed., Pearson Education India, New Delhi (2018).

E-Resources:

1. https://www.youtube.com/watch?v=GWozd0_I0Lk
2. https://www.youtube.com/watch?v=JvZPYh4efLY
3. https://www.youtube.com/watch?v=Kp-jS6NHsB8&list=PLF178600D851B098F
4. https://www.youtube.com/watch?v=8_fLe1KirRY
5. https://www.youtube.com/watch?v=OYMNH4mQzRk
6. https://www.youtube.com/watch?v=mzlOwZ1WqfU
7. https://www.youtube.com/watch?v=tJYSSdVE7SA
8. https://www.youtube.com/watch?v=2zWjG6ZrU0M
9. https://www.youtube.com/watch?v=Tt8zwiniSPc

Unit III & IV

1. S. M.Sze, Semiconductor Devices: Physics and Technology, 3rd Ed., Wiley, India (2016).
2. S. M. Sze and K. K. Ng, Physics of Semiconductor Devices, 4th Ed., John Wiley & Sons, India (2006).
3. D. Nauman, Semiconductor Physics and Devices: Basic Principle, 4th Ed. TMH, New Delhi (2011).
4. B. G. Streetman and S. Banerjee, Solid State Electronic Devices, 7th Ed., Pearson Education India, New Delhi (2018).
5. M. Shur, Physics of Semiconductor Devices, 1st Ed., Pearson Education, New Delhi (2019).
6. A. Mottershead, Electronic Devices and Circuits: An Introduction PHI, New Delhi (1979).
7. A. K. Ganguli, Optoelectronic Devices and Circuits: Theory and Applications, Alpha Science International Ltd., New Delhi (2007).
8. A. P. Malvino, D. P. Leach and G. Saha, Digital Principles and Applications, 8th Ed., TMH, New Delhi (2014).
9. C. B. Agrawal and M. K. Garg, Digital Circuits and Systems, Umesh Publication.
10. C. B. Agrawal, Digital Circuits and Systems, Himalaya Publishing House, New Delhi (2006).

E-Resources:

1. https://youtu.be/c0fs-sNWmMM
2. https://www.youtube.com/watch?v=MuBiC9yz2fc
3. https://www.youtube.com/watch?v=qKx8dM_W1RE
4. https://www.youtube.com/watch?v=VSUOFdMN00E
5. https://www.youtube.com/watch?v=WWjldCmRteg
6. https://www.youtube.com/watch?v=N01BYteinzE
7. https://youtu.be/5ANf30F75jo https://www.youtube.com/watch?v=2aRwFWhLk0o
8. https://www.youtube.com/watch?v=2aRwFWhLk0o
9. https://www.youtube.com/watch?v=CeD2L6KbtVM
10. https://youtu.be/03j4ZvQCKWY

M. Sc. (Physics) SEMESTER – II

PHY – 410: Solid State Properties & Electronic Communications

Learning Objectives:

- To understand the fundamentals and theories of magnetic properties of solids.
- To learn the concepts and theories of diamagnetism, paramagnetism, ferromagnetism, antiferromagnetism and ferrimagnetism.
- To be able to solve problems related to magnetic properties of solids
- To comprehend the principles and theories pertaining to the various kinds of imperfections in solids.
- To learn the concepts of various kinds of dislocations in solids.
- To study of role of dislocations in crystal growth and their applications.
- To be able to solve problems related to imperfections in solids.
- The syllabus covers all the advanced topics of CSIR-NET model syllabus.
- To learn principle and theory of fibre optic communication.
- To understand various parameters associated with the fibre optic communication system.
- Advantages and disadvantages of fibre optic communication system.
- Learn about various techniques of analogue and digital modulation.
- Learn to analyse the various modulation circuits.

Learning Outcomes:

- Use a variety of physical theories and concepts related to technology to address advanced societal needs and challenges.
- Create and put into use a physical model or system for practical purposes.
- Display an advanced research project that qualifies for admission to a PhD programme.
- Distinguish between various magnetism theories and their applications.
- Comprehend the advantages and disadvantages of various magnetism theories.
- Distinguish between different theories of defects and dislocations and how they are used in real life.
- Recognise the benefits and drawbacks of different ideas about defects and dislocations.
- Enhance the skill of problem-solving pertaining to the theories.
- Apply various physical concepts and theories related to technology in order to ease the problems related to societal need at advanced level.
- Develop and Implement physical model/system for real life uses.
- Exhibit research level project which can be used to join in doctoral program.
- Differentiate between different modulation techniques.
- Understand merits and demerits of different modulation methods.

Unit -I :Magnetic Properties of Solids:

Introduction, Magnetic susceptibility, classification of materials, Atomic Magnetic Moment, Diamagnetism: Langevin's formula for the susceptibility of diamagnetism of core electrons, Paramagnetism: Free ion paramagnetism, conduction electron paramagnetism, Quantum theory of paramagnetism

Ferromagnetism: Introduction, Domain Theory, Magnetostriction, Origin of domains, Weiss molecular field, Domain walls, Energy considerations, Hysteresis, Antiferromagnetism, Ferrimagnetism, Problems.

Unit -II: Imperfections in Solids:

Classification of Imperfections, Point imperfections, Line imperfections, Shear strength and process of plastic flow, types of dislocations, Stress fields of dislocations, planer imperfections, Role of dislocations in crystal growth, strength of alloys, Problems

Defect creation by ion beams : Possibilities of tailoring the materials properties with ion beams, nuclear and electronic energy loss in materials, consequence of large electronic energy density deposition by swift heavy ions.

Unit – III: Fiber Optic Communication:

Principles of light, transmission in a fiber - propagation with in a fiber, fiber index profiles, Modes of propagation modes in step index fiber, single mode fiber. Losses in fibers – Rayleigh scattering losses, absorption losses, leaky modes, mode coupling losses, bending losses, combined fiber losses. Dispersion - effect of dispersion on pulse transmission, intermodal dispersion, material (chromatic) dispersion, waveguide dispersion, total dispersion and maximum transmission rates. Light sources and detectors for fiber optics. optical receiver circuit. Connectors and splices - losses in connectors and splices, connectors, fibre splices. Fiber optic communication link.

Unit – IV : Modulation Techniques:

AM and FM modulation:

Amplitude modulation: Theory of amplitude modulation, Frequency spectrum of AM wave, AM modulator and detector. Single side band modulation: Single sideband principle, Angle Modulation: Theory of frequency and phase modulation, frequency spectrum of FM wave.

Pulse Modulation:

Pulse Modulation: Pulse amplitude modulation, Pulse code modulation, Pulse time modulation, Pulse position modulation, Pulse width modulation, Digital carrier systems: Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Continuous Phase Frequency Shift Keying (CPFSK), Minimum Shift Keying (MSK), Phase Shift Keying (PSK).

Reference books:

Unit I & II

1. C. Kittle, Introduction to Solid State Physics, 8th Ed., Wiley Eastern Limited, New Delhi (2018).
2. J. P. Srivastava, Elements of Solid State Physics, 4th Ed., PHI Learning Private Limited, Delhi (2016).
3. C. M. Kachhava, Solid State Physics, Solid State Devices and Electronics, New Age International Publishers, New Delhi (2011).
4. S. O. Pillai, Solid State Physics, 10th Ed. New Age International Publishers, New Delhi (2023).
5. S. L. Kakani and C. Hemrajani, Solid State Physics – Theory, Applications and Problems, Sultan Chand and Sons, New Delhi (2014).
6. B. S. Saxena, P. N. Saxena, R. C. Gupta and J. N. Mandal Fundamentals of Solid State Physics, 32nd Ed., Pragati Prakashan, Meerut (2022).
7. A. K. Saxena, Solid State Physics (With an Introduction to Semiconductor Devices), 3rd Ed., Trinity Press, New Delhi (2014).
8. G.K. Mehta and D.K. Avasthi, Swift Heavy Ions for Materials Engineering and Nanostructuring, Spinger **:** Springer Series in Materials Science (SSMATERIALS, volume 145)(2011)

E-Resources:

1. https://www.youtube.com/watch?v=uAS3c2zAD70
2. https://youtu.be/QQZ6EGf0Ju8
3. https://youtu.be/erBG_qNjgd8
4. https://youtu.be/6W6W31I5cm4
5. https://www.youtube.com/watch?v=DDLljK1ODeg
6. https://www.youtube.com/watch?v=IMlc8Fz5k0Y
7. https://youtu.be/e4K1EDQ3NHI

8. https://youtu.be/XRAOtteqU1I
9. https://youtu.be/QA8KDRS5u9k
10. https://youtu.be/HU9fiPjDoY4
11. https://youtu.be/OT8skdD6tVQ
12. https://youtu.be/B0CdDAn9X9s
13. https://youtu.be/LNU0oEKaSHY
14. https://www.youtube.com/watch?v=RGx0bC9Q-6w
15. https://www.youtube.com/watch?v=gTa6IWGG-8I
16. https://youtu.be/Exp7ZpYgst0
17. https://youtu.be/0l-kivuIOT8
18. https://youtu.be/04OXTWWSyhw
19. https://youtu.be/DfefYbZLrgg
20. https://youtu.be/R0bUquxjQqk
21. https://youtu.be/R0bUquxjQqk
22. https://youtu.be/mhohpKGOsxc
23. https://youtu.be/yU2bB9QFTIo
24. https://www.youtube.com/watch?v=X-XG5RHlC-E
25. https://www.youtube.com/watch?v=OzIPAhILZd0

Unit III & IV

1. D. Roddy and J. Coolen, Electronic Communications, 4th Ed., Pearson India, New Delhi (2014).
2. W. Tosmasi, Advanced Electronic Communication System, 6th Ed. Pearson India, New Delhi (2015).
3. G. Keiser, Optical Fiber Communications, 5th Ed., MGH, New Delhi (2017).
4. J. M. Senior, Optical Fiber Communications-Principles and Practice, Pearson, New Delhi (2014).
5. G. Kennedy, B. Davis and S. Prasanna, Electronic Communication Systems, 5th Ed., TMH, New Delhi (2011).
6. H. Taub, D. L. Schilling and G. Saha, Principle of Communication Systems, TMH, New Delhi (2007).
7. V. Chandra Sekar, Communication Systems, Oxford University Press, New Delhi (2012).

E-Resources:

1. https://youtu.be/ougKUUM3hJA
2. https://youtu.be/F3slBe2r8vA
3. https://youtu.be/m845-5JHkVI

M. Sc (Physics) SEMESTER – II

PHY– 411 PR : PRACTICALS

Learning Objectives:

To be familiarize with various digital and timer ICs operation and their applications

To learn about the radioactive decay using GM counter

To learn about the properties of optical fiber, wave guides and optoelectronic devices

To study some semiconductor properties.

Learning Outcomes:

Students will be familiar with various digital and timer ICs operation and their applications

Students will know about the radioactive decay phenomenon.

Students will be familiar with properties of optical fiber, wave guides and optoelectronic devices

Students will be familiar with some semiconductor properties.

Sr.No.	Title of the Practical
1	Hall effect
2	Spherical harmonics
3	Study of Amplitude Modulation and Demodulation using Trainer kit.
4	Absorption coefficient of Beta particles of Aluminum
5	Study of Transmission Line characteristics using Trainer Kit.
6	Resistivity of a semiconductor by four probe method
7	Characteristics of optical fiber.
8	Characteristics of Optoelectronic devices
9	Diagonalization of Symmetric matrix (3x3).
10	Experiments on optical fiber communication.
11	Design and Study of Astable & Monostable Multivibrator using IC 555.
12	Design and Study of different types of Flip-Flops using IC 7400,7402 & 7473.
13	Study of different types of Shift Registers using IC 7493.
14	Design and study of decade counter and divide by six counter using IC 7490.
15	Determination of Guide Wavelength of a rectangular wave guide.

15% of new experiments can be introduced AND / OR replaced as per the need, with the permission of the Chairman of Board of studies.

M. Sc (Physics) SEMESTER – II

PHY - 412 PT : POJECT

- In-house project work of 4-credit to be performed by each student.
- Alternatively, MOOC, Swayam or any other UGC recognized online course in Physics of at least 03 weeks duration and equivalent to 4 credits will also be considered for 4-credit in this course.
- Every student shall work on a project under a faculty member of the department.
- Project work may be carried out within the department or in other department, or from other institution (if required).
- Allotment of the supervisors shall be done by the Department.
- The supervisor shall act as the instructor for this course on project and make continuous assessment based on the understanding/ literature survey, experimental/ theoretical formulation, performance, interpretation of results and writing of Report.
- End-semester evaluation will be based on evaluation of report, presentation and viva voce examination of the candidate at the end of the semester by a panel of examiners.

GUJARAT UNIVERSITY

Revised Syllabus

To be implemented from Year 2025-2026

M. Sc (Physics)

SEMESTER – III

Course	Name of the Course	Lect. Hrs. / Week	Marks			Course Credits
			Internal	External	Total	
PHY-501	Advanced Quantum Mechanics and Instrumentation	4	30	70	100	4
PHY-502	Numerical Analysis & Classical Mechanics - II	4	30	70	100	4
PHY-503	Nuclear Physics - II & Microprocessor - II	4	30	70	100	4
PHY-504	Microwaves & Thin Film Technology	4	30	70	100	4
PHY-505 PR	Practicals	8	30	70	100	4
PHY-506 PT	Project	8	30	70	100	4
TOTAL		**32**	**180**	**420**	**600**	**24**

PHY – 501: Advanced Quantum Mechanics and Instrumentation

Learning Objectives:

- The study of advance level quantum mechanics gives insight to understand the concepts of scattering, differential and total cross sections and phase shift through Born approximation method. This gives basic understanding to develop such concepts of physics in quantum physics.
- In scattering theory, Born approximation, complex potential and absorption are studied along with this the essential experimental techniques for physical sciences are covered.
- Two important courses on quantum mechanical description of angular momentum and relativistic wave equation are foundations of high energy physics in which advance research is going on.
- Absorption are studied along with the essential experimental techniques for physical sciences are covered
- The syllabus covers all the advanced topics of CSIR-NET model syllabus.

Learning Outcomes:

- Advance Quantum Mechanics are core course.
- A student should be able to take up a research problem in the area of high energy physics.
- Students will be able to solve problems based on these core courses.
- Applied aspects of instrument design would enlighten the instrument design and measurements.

Unit – I: Scattering Theory

Kinematics of the scattering process: differential and total cross sections elastic and inelastic scattering, wave mechanical picture of scattering: the scattering amplitude, Green's functions: formal expression for scattering amplitude. The Born approximation, validity of the Born approximation, The Born series, The Eikonal approximation, Asymptotic behavior of partial waves: phase shifts, The scattering amplitude in terms of phase shift, The differential and total cross sections: optical theorem, Phase shifts: Relation to the potential, Potentials of finite range, Low energy scattering, scattering by a square well potential, scattering by a hard sphere, scattering by a coulomb potential, Complex potential and absorption.

Unit – II : Angular Momentum:

Eigen value spectrum, Matrix representation of J in the |jm> basis, Spin angular momentum, Non relativistic Hamiltonian with spin, addition of angular momenta, Clebsch-Gordan Coefficients, Spin wave functions for a system of two spin 1/2 particles, Identical particles with spin, addition of spin and orbital angular momenta, Spherical tensors; Tensor operators, Wigner Eckart theorem, Projection theorem for a first rank tensor.

Unit – III : Relativistic Wave Equations:

Generalization of Schrodinger equation - Klein - Gordan equation : Plane wave solutions; - Charge and Current densities - The Dirac equation : Dirac's Relativistic Hamiltonian – Position Probability density; expectation values - Dirac matrices - Plane wave solution : Energy spectrum - The Spin of the Dirac particle - Significance of negative energy states. – Relativistic electron in a central potential: Total angular momentum - Radial wave equation – Series solutions of the radial equation: asymptotic behavior - Determination of the energy levels –Spin magnetic moment - Spin-orbit energy.

Unit – IV: Transducers, Measurement and Controls:

Transducers : Desired characteristics of transducer, Different transducers : Temperature, Capacitive, Magnetic field, LVDT, Optical, Piezoelectric, Pyrometer.

Measurement and Control : Types of noises in electrical systems, Signal to noise ratio, Enhancement of signal to noise ratio, Signal conditioning and recovery, Impedance matching,

filtering and noise reduction, shielding and grounding, Phase sensitive detector and lock-in amplifier.

Reference Books:

Unit I & II

1. P. M. Mathews and K. Venkatesan, A Text Book of Quantum Mechanics, 2nd Ed. TMH, New Delhi (2011).
2. V. K. Thankappan , Quantum Mechanics, New Age International Publishers, 5th Ed., New Delhi (2020).
3. G. Aruldhas, Quantum Mechanics, 2nd Ed. PHI Learning Pvt. Ltd., Delhi (2017).
4. A. Ghatak and S. Loknathan, Quantum Mechanics, 6th Ed., Trinity Press, New Delhi (2019).
5. L. I. Schiff, Quantum Mechanics, 4th Ed., Tata McGraw Hill Edu., New Delhi (2017).
6. D. J. Griffiths and D. F. Schroeter, Introduction to Quantum Mechanics, 3rd Ed., Cambridge University Press India Pvt Ltd (2019).

E-Resources

1. https://youtu.be/oEWsimmWy5E
2. https://youtu.be/iCmV7JFRJxs
3. https://youtu.be/CJNXrPtE5oI
4. https://youtu.be/LJgXB-K1c90
5. https://youtu.be/737Hp6JT4sw
6. https://www.youtube.com/watch?v=fH43herEqmo
7. https://www.youtube.com/watch?v=iyb5CToifko
8. https://www.youtube.com/watch?v=SKHcfI8dyIc
9. https://www.youtube.com/watch?v=cP3Fk7pATDg
10. https://www.youtube.com/watch?v=3CR13G7GQfc
11. https://www.youtube.com/watch?v=Q8dZTALgGH4
12. https://youtu.be/4KxKSr37z3U
13. https://youtu.be/kZDhRDgHt70
14. https://youtu.be/6r9jtEPppRY
15. https://youtu.be/zy9aLwWtGDU
16. https://youtu.be/vHZY4ZDnGVE
17. https://youtu.be/Ul0XpyuLttI
18. https://youtu.be/dEOATGA9dVk
19. https://youtu.be/pYG8I0ENlEg

Unit III & IV

1. M. Sayer and A. Mansingh, Measurement, Instrumentation and Experimental Design for Physicists and Engineers, PHI, New Delhi (1999).
2. J. P. Holman, Experimental Systems, Applications and Design, TMH.
3. A. K. Sawhney, A course in Electrical and Electronic Measurements and Instrumentation, Dhanpatrai and Sons. Co. (2015)

E-Resources

1. https://youtu.be/77A9xWz_ugo
2. https://youtu.be/77A9xWz_ugo
3. https://youtu.be/77A9xWz_ugo
4. https://youtu.be/2d2wP6MSiqM
5. https://youtu.be/vjpUFF51taU
6. https://youtu.be/d_R57A7GGvs

PHY – 502: Numerical Analysis & Classical Mechanics – II

Learning Objectives:

- Understand the importance of Ordinary differential equations in Physics
- Understand the classification, rank and order of Ordinary differential equation
- To study various numerical methods of solving Ordinary differential equation
- Understand the importance of partial differential equations in Physics
- Understand the classification, rank and order of partial differential equation
- To study various numerical methods of solving partial differential equation
- Classical mechanics: The study of classical mechanics gives insight to understand some fundamental laws of physics in the classical domain.
- Interesting and interactive topics of linear and non-linear oscillations leading to chaotic motion. How the Logistic Map can be used to understand Chaos.
- Students will learn the concepts of relativistic dynamics, Minkowski's space, and the transformation equations.
- The transition from a discrete to a continuous system using the Lagrangian and Hamiltonian formulations.

Learning Outcomes:

- Student will know the importance of ordinary differential equations in Physics.
- Student will be able to understand the classification, rank and order of ordinary differential equation.
- Students will be able to solve ordinary differential equations using various numerical methods.
- Student will know the importance of partial differential equations in Physics.
- Students will understand the classification, rank and order of partial differential equation.
- Students will be able to solve partial differential equations using various numerical methods.
- Students will learn interesting and interactive topics of linear and non-linear oscillations can be grasped using demonstrations and mathematical analysis.
- The computational skill will be developed while understanding the Logistic Map leading to Chaos.
- Students will learn the concepts of relativistic dynamics, Minkowski's space, and the transformation equations will be led to understand the dynamics at very high velocity.
- The concept of understanding the transition from a discrete to a continuous system.

Unit – I: Numerical Solution of Ordinary Differential equations:

Introduction, Picard's method, Taylor's series method, Euler's method, Modified Euler's method, Runge's method, Runga-Kutta method, Predictor-corrector method, Milne's method, Adams-Bashforth method.

Unit – II : Numerical Solution of Partial Equations

Introduction, Classification of second order equation, Finite difference approximations to partial derivatives, Elliptic equations, Solution of Laplace Equation, Solution of Poisson's Equation, Parabolic Equations, Solution of one-dimensional heat equation, Solution of two-dimensional heat equation, Hyperbolic equations, Solution of wave equations.

Unit – III : Non-Linear Oscillations and Chaos:

Non-Linear Oscillations

Introduction, Singular Points of Trajectories, Nonlinear Oscillations, Limit cycle.

Chaos

Logistic Map, Poincare System, Strange attractors.

Unit – IV: Relativistic Electrodynamics and Classical Field Theory:

Relativistic Mechanics, The Structure of Space Time: Four Vectors, The Invariant interval, Space Time diagrams, Proper time and proper velocity, Relativistic energy and momentum, Relativistic kinematics, Relativistic dynamics, Relativistic electro dynamics, How field transform. The field tensor, Electro dynamics in tensor notation, Relativistic potentials. The transition from a discrete to a continuous system., The Lagrangian formulation for continuous system, Sound vibrations in gases as an example of Lagrangian formulation, The Hamiltonian formulation for continuous system, Description of fields by variational principles.

Reference Books:

Unit I & II

1. S. Grewal and J. S. Grewal, Numerical Methods in Engineering and Science, Khanna Publishers, New Delhi (2002).
2. E. Balgurusamy, Numerical Methods, TMH Pub. Co. Ltd, New Delhi (2000).
3. R. Srivastava and S. Guha, Numerical Methods: for Engineering and Science, OUP India (2010).
4. S. C. Chapra and R. P. Canale, Numerical Methods for Engineers, 8th Ed., TMH, India (2021).
5. A. Gilat and V. Subramaniam, Numerical Methods for Engineers and Scientists An Introduction with Applications using MATLAB, 3rd Ed., Wiley, USA (2014).

E-Resources

1. https://youtu.be/0_gyh-LSt6o
2. https://youtu.be/_LX1p0VFkp4
3. https://youtu.be/TWAN_T66Cps

Unit III & IV

1. R. G. Takwale and P. S. Puranik, Introduction to Classical Mechanics, 55th Ed., TMH, New Delhi (2016).
2. H. Goldstein, C. P. Poole, J. L. Safko, Classical Mechanics, 3rd Ed., Pearson India, New Delhi (2011).
3. A. B. Bhatia, Classical Mechanics Classical Mechanics: With Introduction to Nonlinear Oscillations and Chaos, Narosa Pub. House, New Delhi (2001).
4. J. C. Upadhyay, Classical Mechanics, Himalaya Publishing House, Mumbai (2016).
5. G. Aruldhas, Classical Mechanics, 8th Ed., PHI Learning Private Limited, New Delhi (2017).
6. S. N. Biswas, Classical Mechanics, Books & Allied Ltd., New Delhi (2014).

E-Resources

1. https://youtube.com/playlist?list=PLUeHTafWecAUqSh3Gy0NNr7H3OsXoC-aK&si=JMdJTI20tTa38Y24
2. https://youtu.be/zdKjscoLUmI
3. https://youtu.be/iGlRaD_gO7Q?si=ol-Vmu8-9a42BbwP
4. https://youtu.be/fjJsX4ektBA?si=rGnz3x_J77678XPF

PHY – 503: Nuclear Physics – II and Microprocessor – II

Learning Objectives:

- Advanced concepts of nuclear physics such as different types of nuclear reactions, particle physics have fundamental and applied aspects.
- Programming (set of instructions) is an integral part of any Microprocessors.
- The main objective of Microprocessor – II course is to familiarization with 8085 MPU instructions, programming techniques, and debugging programs using static and dynamic techniques.
- These courses are part of CSIR-NET syllabus.

Learning Outcomes:

- Students should be able to take up a research problem in high energy physics areas.
- Advanced nuclear physics ideas, such as the various kinds of nuclear reactions and the fundamental and practical components of particle physics, should be taught to students.
- Software (instructions) is an integral part of microprocessor and demands emphasis equal to that of hardware.
- After learning this course on Microprocessor – II almost all the 8085 microprocessor instructions, programming techniques, program development systems are covered.
- Students are expected to learn themselves assembly language programming and debugging techniques independently.

Unit – I: Nuclear Reactions:

Nuclear reactions and cross sections, Resonance: Breit Wigner dispersion formula for l=0, compound nucleus, continuum theory of nuclear reaction, Direct reactions, theory of stripping reactions- semiclassical description and wave description, single particle shell model, spin – orbit potential, analysis of shell model- predictions- spins and parities of nuclear ground states, magnetic moments, electric quadrupole moment, nuclear isomerism, stripping reaction and shell model.

Unit – II : Particle Physics:

Collective Nuclear Model: Rotational states and vibrational states, Brief description of Nilson model.

Particle Physics: Classification of elementary particle, types of interaction, quantum numbers of elementary particle, Strangeness, parity, charge conjugate, time reversal, CPT theorem, Iso-spin, Consequences of Iso-spin invariance, G-parity, CP-violation in K^0 meson decay, Gell Mann Nishijima scheme, Isospin and SU(2), SU93), Multiplets, Gell Mann Okubo mass formula, Quarks-antiquarks, fundamental interaction of quarks and drawbacks of quarks.

Unit – III : Introduction and Programming Techniques

Introduction to 8085 instructions:

Data transfer (copy) operations, Arithmetic and logical operations, Branch operations and Machine control operations. Writing Assembly language programs.

Programming Techniques with Additional Instructions:

Programming Techniques: Looping, Counting and Indexing, conditional loop, counter, 16-bit Arithmetic instructions, 16-bit data transfer to Registers pairs (LXI), Arithmetic operations related to 16-bits (Register Pairs).

Logic operations: Rotate, Applications of Rotate instructions.

Illustrative program: Checking sign with Rotate instructions.

Unit – IV: Counters and Time delay, Stack and Subroutine:

Code Conversion, BCD Arithmetic and 16-bit data operations

Counters and Time delay:

Counter, Time delay- using one Register, a Register pair, a loop within loop technique, Delay calculations, Additional techniques, Counter design with time delay, Hexadecimal zero to nine (Modulo ten Counters), Illustrative program: Generating pulse wave forms, Debugging counter and time delay programs.

Stack and Subroutine:

Concepts of Stack and Subroutine, Examples,

Illustrative programs: Resetting and displaying flags, Traffic Signal Controller, Multiple calling of a subroutine Restart, Conditional call and Return instructions.

Advance subroutine concepts: Nesting, Multiple ending subroutines, Similarities and differences between CALL-RET, PUSH-POP instructions, Code Conversion.

BCD Arithmetic and 16-bit data operations:

BCD: Addition, subtraction, multiplication.16-bit operations.

Reference books:

Unit I & II

1. H. A. Enge, Introduction to Nuclear Physics, Addison-Wesley Publishing Company (1966).
2. R. R. Roy and B. P. Nigam, Nuclear Physics Theory and Experiments, 2nd Ed., New Age International Pvt. Ltd. New Delhi (2014).
3. D. C Tayal, Nuclear Physics, Himalaya Publishing House, Mumbai (2011).
4. S. B. Patel, Nuclear Physics: An Introduction, New Age Int. Pub., New Delhi (2021).
5. J. Singh, Fundamentals of Nuclear Physics, Pragati Prakashan, Meerut (2021).
6. K. S. Krane, Introductory Nuclear Physics, John Willey & Sons, New York (1988).

E-Resources:

1. https://youtu.be/5KOJLxcaQto
2. https://youtu.be/652um-WaWMM
3. https://youtu.be/6PjF0jLjSQc

Unit III & IV

1. A. P. Malvino, D. P. Leach and G. Saha, Digital Principles and Applications, 8th Ed., Tata McGraw-Hill Publishing Company Limited, New Delhi (2014).
2. A. Kumar, Fundamentals of Digital Circuits, 4th Ed., PHI Private Limited, New Delhi (2016).
3. M. Morris Mano, Digital Logic and Computer Design, PHI Private Limited, New Delhi (2006).
4. A. K. Maini, Digital Electronics Principles, Devices and Applications, 1st Ed., John Wiley & Sons Ltd, England (2007).

E-Resources:

1. https://www.youtube.com/watch?v=CeD2L6KbtVM
2. https://www.youtube.com/watch?v=BqP6sVYlrr0
3. https://www.youtube.com/watch?v=sUutDs7FFeA
4. https://youtu.be/oNh6V91zdPY
5. https://youtu.be/lw21I8VBTrQ
6. https://youtu.be/ApILP5WPZeE
7. https://www.youtube.com/watch?v=TirvWsbqBUc
8. https://www.youtube.com/watch?v=xdoAB7jevk0

PHY – 504: Microwaves and Thin Film Technology

Learning Objectives:

- To develop understanding of the operation, properties and behaviour of some of the microwave active and passive devices.
- To develop basic understanding of the analysis of microwave networks.
- To learn some of the microwave measurement techniques.
- To learn basic designs and fundamentals of vacuum pumps and its applications.
- To develop concept of thin film growth and different deposition techniques.
- Students will learn the basic and instrumentation of different spectroscopy for structural and surface properties of materials.

Learning Outcomes:

- Recognise and use microwave components in a microwave system.
- Design and develop microwave components.
- Analyse simple microwave network.
- Perform experiments based on microwave measurement techniques.
- To understand the designs, functions and components working of different types of vacuum pumps, measurement methods using different gauges and its applications to creates and control vacuum.
- To gain the fundamental knowledge about fabrications of thin films under controlled growth mechanism by using variety of deposition techniques such as PVD, E-Beam epitaxial method, sputtering, PLD and CVD.
- Students will learn how to analyse the structural properties and quality of thin films by using different spectroscopy such as XRD, SEM, TEM, EDAX, Raman Spectroscopy, FTIR and UV-VIS.

Unit – I: Microwave Active Devices:

Klystrons, Magnetrons and Traveling wave tubes, Velocity modulation, Basic principle of two cavity klystrons and Reflex Klystrons, principles of operation of magnetrons, helix traveling wave tube wave modes, transferred electron devices, Gunn effect, principle of operation, modes of operation of Gunn diode, Impatt diode.

Unit – II : Microwave Passive Circuit Components and Measurements:

Attenuators, E-plane tee, H-plane tee and hybrid tee, directional couplers, isolator and circulators, Detection of microwaves, microwave power measurement, measurement of impedance and frequency.

Unit – III : Thin Film Technology:

Vacuum and Thin film Deposition:

Creation of Vacuum with different Vacuum Pumps, Measurement of Vacuum with different Gauges. Evaporation Theory. Physical Vapour Deposition methods- Thermal and Electron Beam evaporation, DC and RF sputtering, Pulsed Laser Deposition CVD methods. Various types of CVD reactions.

Growth of thin films: Substrates Cleaning, Condensation, Nucleation Structural Consequences. Growth stages.

Unit – IV: Characterization Techniques:

Surface and bulk structure determination techniques : X-ray Diffraction, Grazing Incidence XRD, Electron Diffraction, LEED and RHEED Techniques, Electron Microscopy : Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Chemical analysis : Electron Probe Microanalysis-EDAX, Auger Electron Spectroscopy, X-ray photoelectron spectroscopy, FTIR-spectroscopy, Raman spectroscopy, UV-Visible spectroscopy.

Reference Books:

Unit I & II

1. S. Y. Liao, Microwave Devices And Circuits, PHI, New Delhi (1995).
2. M. Kulkarni, Microwave and Radar Engineering, Umesh Publication, Delhi (1998).
3. K. C. Gupta, Microwave, Wiley Eastern Ltd., New Delhi (1985).
4. D. C. Sarkar, Microwave Propagation and Techniques, S. Chand and Company, New Delhi (1990).
5. G. Kennedy, B. Davis and S. Prasanna, Electronic Communication Systems, 5th Ed., TMH, New Delhi (2011).
6. D. Roddy and J. Coolen, Electronic Communications, 4th Ed., Pearson India, New Delhi (2014).

E-Resources:

1. https://youtu.be/K8bItHwpFZ8
2. https://youtu.be/vgIMF4hisrk?si=rk0_FHaYSEL4GO6R

Unit III & IV

1. M. Ohring, Materials Science of Thin Films: Deposition and Structure, Academic Press Inc., NY (2001).
2. L. I. Maissel and R. Glang, Handbook of Thin Film Technology, McGraw Hill Int. Edition, NY (1970).
3. K. L. Chopra and L. K. Malhotra, Thin Film Technology and Applications, TMH, New Delhi (1984).

E- Resources:

1. https://youtu.be/Vuqk-Ag7xV4
2. https://youtu.be/NvCDu54y__k
3. https://youtu.be/oB9M2uTDUpI
4. https://youtu.be/snMwYxlyUfc
5. https://youtu.be/FTptkrKcehk
6. https://youtu.be/RARjXXaFEQ0
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16. https://youtu.be/HAq1bmSDoKI
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18. https://youtu.be/CAVF-OqgR3I
19. https://youtu.be/0PNhq5ZOuu0
20. https://youtu.be/kNQ89Od8gtg
21. https://youtu.be/pPjUWEWAGLM
22. https://youtu.be/FGv_chkCmHo
23. https://youtu.be/wJ9PY5uE0Ns
24. https://youtu.be/Dc9s4pLmIyk
25. https://youtu.be/ULY7iprHlLw
26. https://youtu.be/X0WFaTY3jxg

27. https://youtu.be/hTeGun18nTw ,
28. https://youtu.be/LDmajehT5rM
29. https://youtu.be/6iUNJjSgxyk
30. https://youtu.be/Blv6RkdbrTk
31. https://youtu.be/qnv7wkPmg3o
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33. https://youtu.be/NY9IKM1Px0M
34. https://youtu.be/3y6qsrCkrSw
35. https://youtu.be/he1-hE-Usp4 ,
36. https://youtu.be/MgMSjZhoOJI
37. https://youtu.be/bhEgNL52X-g
38. https://youtu.be/6OGnB9tywtI
39. https://youtu.be/cYgwP5Uyzjs
40. https://youtu.be/NMwFuw1weO4 ,
41. https://youtu.be/6zJWhIjzN2c
42. https://youtu.be/9lwnE77utoo
43. https://youtu.be/qKBnLqFn_X8
44. https://youtu.be/2CsMpEBl5QY
45. https://youtu.be/Zz6VCqYwt-U
46. https://youtu.be/tXiiDY31xrE
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49. https://youtu.be/BsUkdEzAfNo
50. https://youtu.be/5tIUE_xkr74
51. https://youtu.be/nqgYuLKDcMQ
52. https://youtu.be/7rhy9f6jYC4
53. https://youtu.be/ApGIrUYbtK8
54. https://youtu.be/mC0rYNlMz9Q
55. https://youtu.be/9Mv1MEKLAhQ
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73. https://youtu.be/BWkpWxa18t0
74. https://youtu.be/czG3YjLpVkM
75. https://youtu.be/Vl3BYsoif-c

M. Sc (Physics) SEMESTER – III

PHY– 505 PR: PRACTICALS

Learning Objectives:

To be familiarize with 741 and 723 ICs operation and their applications

To learn about the operation of GM counter and Ultrasonic interferometer

To study electronic bands of crystalline solids.

Learning Outcomes:

Students will be able to Design and test various electronic circuits using 741 and 723 ICs.

Demonstrate the functioning of various scientific instruments.

Sr.No.	Title of the Practical
1	Born Approximation
2	Phase space trajectories of non linear oscillations
3	Determination of dielectric constant of a given sample at microwave frequency.
4	Determination of optical band gap
5	Design and Study of Two Stage Amplifier using ICs 741.
6	Writing and Execution of simple Programs using Microprocessor 8085 Kit.
7	Writing and Execution of advanced Programs using Microprocessor 8085 Kit.
8	Writing and Execution of advanced Programs using Microprocessor 8085 Kit.
9	Performance of a vacuum pump and verification of Gaede's equation
10	Study of X - ray powder pattern
11	I-V characteristics of a Gunn Diode
12	Mode characteristics of klystron
13	LASER determination of grating element
14	Efficiency of solar cell
15	Linear combination of atomic orbitals

15% of new experiments can be introduced AND / OR replaced as per the need, with the permission of the Chairman of Board of studies.

M. Sc (Physics) SEMESTER – III

PHY - 506 PT : POJECT

- In-house project work of 4-credit to be performed by each student.
- Alternatively, MOOC, Swayam or any other UGC recognized online course in Physics of at least 03 weeks duration and equivalent to 4 credits will also be considered for 4-credit in this course.
- Every student shall work on a project under a faculty member of the department.
- Project work may be carried out within the department or in other department, or from other institution (if required).
- Allotment of the supervisors shall be done by the Department.
- The supervisor shall act as the instructor for this course on project and make continuous assessment based on the understanding/ literature survey, experimental/ theoretical formulation, performance, interpretation of results and writing of Report.
- End-semester evaluation will be based on evaluation of report, presentation and viva voce examination of the candidate at the end of the semester by a panel of examiners.

GUJARAT UNIVERSITY

Revised Syllabus

To be implemented from Year 2025-2026

M. Sc (Physics)

SEMESTER – IV

Course Number	Course Name	Credit	Internal Marks	External marks	Total Marks
PHY-507	PROJECT DISSERTATION	20	150	350	500
PHY-508	SCIENTIFIC WRITNIG AND FIELD WORK	04	30	70	100
TOTAL		**24**	**180**	**420**	**600**

M. Sc (Physics) SEMESTER – IV

PHY-507: PROJECT DISSERTATION

Learning Objectices:

- To make students familiar with approach to do literature survey
- To make student capable of independent thinking and there by enable the student to develop aptitude to carry out research independently.
- Students will learn basic techniques for carrying out research. To Acquire skills to plan and execute experiments individually as well as in groups.

Learning Outcomes:

After completion of this project, students will be able to learn about:

- Basic of literature review on relevant topic
- Techniques used for performing research.
- Analyze the results and tabulate them in a proper manner
- How to write and dissertation, making presentation and viva etc

Modalities of Major Project/Dissertation:

- Every student shall work on a research project under a faculty member of the department.
- Project work may be carried out within the department or in other department, or from other institution (if required).
- Allotment of the supervisors shall be done by the Department. As far as possible, equal distribution of students should be maintained per faculty member, and the allotment may be done during the third semester.
- The supervisor shall act as the instructor for this course on Dissertation and make continuous assessment based on the understanding, literature survey, experimental/ theoretical formulation, performance, interpretation of results and writing of Report and Dissertation.
- End-semester evaluation will be based on evaluation of report, dissertation, presentation and viva voce examination at the end of the fourth semester by a panel of examiners.
- Student should opt for full semester long dissertation work on the campus or outside the campus in some Laboratories/Institutes/Universities / Industry/ organisation of National Importance.
- For carrying out the dissertation work outside the campus, student will have to produce an invitation/acceptance letter from external supervisor by the end of Semester III.
- Permission from the Department is required for pursuing the project work outside the campus. Student may complete the dissertation project under the guidance of a supervisor of the Department.
- Student who will pursue the project outside GU will have one internal supervisor and one external supervisor. Internal supervisor will periodically interact with student and external supervisor. Supervisor will be responsible for internal assessment of the candidate from time to time.
- Student will be allowed to work with external supervisor at other outside institutions only after completing all the documentation process at GU.

- Students must follow the timeline strictly issued by Department from time to time.
- Department will have no financial obligation regarding the project work carried out by the student.
- Student must abide by the attendance rules and regulations of the Gujarat University.
- Two typed/computerised bound copies of the dissertation shall be submitted to the University during the final M.Sc. at least fifteen days before the commencement of the final examination.
- Presentation and viva-voce: Student shall present and defend the report to examiners. Examiners will test the research skills and knowledge of the student based on the submitted hard copy of the dissertation and the oral presentation.

M. Sc (Physics) SEMESTER – IV

PHY-508: SCIENTIFIC WRITNIG AND FIELD WORK

Learning Objectices:

- To enable the student to learn the scientific writing, conference report writing by collecting, evaluating information that elaborates on a scientific topic using facts, charts, and graphs to support its arguments and findings.
- To enable the student to present a scientific topic of subject relevance, thereby, developing oral presentation and oratory skills.

Learning Outcomes:

- Field work/academic visits will let student to reflect the educational value of a trip, including any objectives the student might have and unexpected learning experiences.
- Students will learn to highlight the impact of the field work on the student's chosen discipline and will serve to develop inspiration

Modalities and general guidelines:

- The candidate is required to show the scientific topic on which candidate want to write a detailed report to the supervisor before initiating the work and take necessary approval from the supervisor.
- Student has to either choose to study Concepts in Research Methodology or undergo field work or attend a workshop/ seminar/ conference of state/ national/ international level and submit a report. Concepts in research methodology are the principles and techniques that guide the design and conduct of a research project. They include topics such as research paradigms, research questions, literature review, data collection methods, data analysis methods and ethical issues.
- Students opting to study Concepts in Research Methodology must learn the following:
- Searching interest of research, Defining the research question, Approaches and Methodology, objectives, significance and techniques of research
- Introduction to kinds of scientific documents: research paper, review paper, book reviews, theses, and project reports (for the scientific community and for funding agencies).
- Ethics in research: Honesty and integrity, Misconducts: Falsification, fabrication, plagiarism. Best/ standard practices of research.
- Redundant publication: duplication and overlapping of publications, selective reporting and misinterpretation of data. Conflict of interest, Violation of publication ethics: authorship and contributorship.
- Introduction to spreadsheet applications, features o Generating charts / graph and other features, Tools – Microsoft Excel or similar. o Using formulae and functions, Data storage, Standard deviation, standard error
- Web Search: Use of Publication search engines and libraries (PubMed, PubMed central, CrossRef, Google scholar).
- Use of automated referencing softwares (Mendley, Zotero, EndNote, etc.)
- Presentation tools: Introduction, features and functions, slide presentation

- Key aspects of research presentations
- Dully certified two typed/computerised bound copies of the scientific report and the details regarding the field work shall be submitted to the University for the end semester evaluation.

Report evaluation:

- Dully certified report submitted by the candidate should be evaluated by the panel of examiners.
- The supervisor shall act as the instructor for this course make continuous assessment based on the understanding, literature survey, experimental/ theoretical formulation, performance, interpretation of results and writing of Report.
- End-semester evaluation will be based on evaluation of report, presentation and viva voce examination of the candidate at the end of the fourth semester by a panel of examiners.
- Student has to give a seminar on the scientific report and conducted field work to an audience of peers and experts. It is usually accompanied by slides or other visual aids and followed by a question-and-answer session.
- The purpose of presentation/seminar is to share the findings to demonstrate their conceptual understanding of the topic.