Courses and Credit Index

Semester -VII

Sr. No.	Course Title and Code	Credit Structure			
		L	T	P/R	C
	Four Compulsory Theory Papers				
1.	Mathematical Physics (B010701T)	3	1	0	4
2.	Classical Mechanics (B010702T)	3	1	0	4
3.	Electrodynamics and Relativity (B010703T)	3	1	0	4
4.	Quantum Mechanics – I (B010704T)	3	1	0	4
	Minor elective Course from other faculty				
5.	*Minor elective course from other department/faculty				4
	Lab Courses				
6.	General Lab. (B010705P) or Electronics Lab. (B010706P)	0	0	8	4
	Minor elective (value added) course for students of other departments				
8.	$Fundamentals of Physics (B010708M)	4	0	0	4

Semester – VIII

Sr. No.	Course Title and Code	Credit Structure			
		L	T	P/R	C
	Four Compulsory Theory Papers				
1.	Quantum Mechanics – II (B010801T)	3	1	0	4
2.	Statistical Mechanics (B010802T)	3	1	0	4
3.	Solid State Electronics (B010803T)	3	1	0	4
4.	Atomic and Molecular Physics (B010804T)	3	1	0	4
	Minor Course from other faculty				
5.	*Minor Course from other department/faculty				4
	Lab. and Dissertation Courses				
6.	General Lab. (B010806P) or Electronics Lab. (B010805P)	0	0	8	4
7.	Dissertation: Literature Survey and Data Collection (B010807R)	0	0	8+8^	8
	Minor elective (value added) course for students of other departments				
8.	$Frontiers of Physics (B010808M)	4	0	0	4

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Semester – IX

Sr. No.	Course Title and Code	Credit Structure			
		L	T	P/R	C
Two Compulsory Theory Papers					
1.	Solid State Physics (B010901T)	3	1	0	4
2.	Nuclear and Particle Physics (B010902T)	3	1	0	4
	Two Theory Papers from any of the three Specialization	**Credit Structure for EACH PAPER**			
3.	(i) Analog & Digital Electronics (B010903T), (ii) Laser Spectroscopy (B010905T) **or** (iii) Condensed Matter Physics-I (B010907T)	3	1	0	4
4.	(i) Microwaves (B010904T), (ii) Electronic Spectra of Diatomic Molecules (B010906T) **or** (iii) Condensed Matter Physics-II (B010908T)	3	1	0	4
One Lab. Course from the chosen specialization					
5.	(i) Electronics Lab. (B010909P), (ii) Spectroscopy Lab. (B010910P) **or** (iii) Condensed Matter Physics Lab. (B010911P)			8	4

Semester – X

Sr. No.	Course Title and Code	Credit Structure for each course			
		L	T	P/R	C
Electives^{+}					
1.	Experimental Techniques and Control Systems (B011001T)	3	1	0	4
2.	Computational Physics with Python (B011002T)	3	1	0	4
3.	Quantum Information and Computing(B01103T) **or**	3	1	0	4
4.	(i) Quantum Transport (B011016S)	As per SWAYAM			2
	(ii) Topology and Condensed Matter Physics (B011017S)	As per SWAYAM			3
Two Theory Papers from any of the three Specialization					
5.	(i) Microprocessor and Computational Electronics (B011005T), (ii) Advanced Atomic Spectroscopy (B011007T) **or** (iii) Condensed Matter Physics-III (B011009T)	3	1	0	4
6.	(i) Physics of Semiconductor Devices (B011006T), (ii) IR & Raman Spectra of Polyatomic molecules (B011008T) **or** (iii) Condensed Matter Physics-IV (B011010T)	3	1	0	4
One Lab. Course from the chosen specialization and Dissertation					
7.	(i) Electronics Lab. (B011011P), (ii) Spectroscopy Lab. (B011012) **or** (iii) Condensed Matter Physics Lab. (B011013P)			8	4
8.	Dissertation: Final Report submission and Presentation. (B011014R)			8+8^	8

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* : Students of M. Sc. (Physics) programme have to opt and complete one minor course of 4 credits offered by other departments of other faculties in Semester VII or VIII.

: Credit of one minor course is accounted for.

$: Students of other departments can opt for minor (value added) courses offered at our department.

^ : Students shall undertake their dissertation work during both the odd and even semesters; however, the evaluation of the dissertation shall be conducted only at the end of the even semesters.

+ : Students must earn at least 8 credits from the specified group of elective courses.

Students will earn total of at least 52 credits in first year and at least 48 credits in final (second) year of M. Sc. (Physics) programme. Students will have to earn at least 100 credits to complete the degree.

A. Rules for Completion of Course:

Sr. No.	Grades Scores in Individual Courses	Status of Promotion	Eligibility of Completion of Course
1.	'P' or above in all courses/papers	Passed	---
2.	Below 'P' in one or two Courses/papers	Eligible for SE	Second Exam. in which scored below 'P' Grade
3.	Below 'P' in more than two Courses	Failed*	All courses as Ex-student for the semester

* The pass marks in each semester shall be (i) 36% marks in each theory paper, and (ii) 36% marks in practical examination examinations.

B. Grades and Grade Points:

Sr.	Percentage of Marks Obtained	Letter Grade	Grade Point (Gi)	Classification
1.	90% or above	O	10	Outstanding
2.	80% or above but below 90%	A+	9	Excellent
3.	70% or above but below 80%	A	8	Very Good
4.	60% or above but below 70%	B+	7	Good
5.	50% or above but below 60%	B	6	Above Average
6.	40% or above but below 50%	C	5	Average
7.	36% or above but below 40%	P	4	Passed
8.	Below 36%	F	0	Failed
9.	Absent	AB	0	Absent

C. Formulae: $Cpc = Ci \times Gi$; $SGPA = \Sigma Cpc / \Sigma Ci$; $CGPA = \Sigma(SGPA \times \Sigma Ci) / \Sigma(\Sigma Ci)$

D. Abbreviations used in Grade Card:

(Ci) Credit Index; (Gi) Grade Point; (Cpc) Credit Points in the Course;
(SGPA) Semester Grade Point Average; (CGPA) Consolidated Grade Point Average

E. The Multiplication factor for conversion of obtained CGPA into obtained percentage will be 9.5.

Note:

Percentage (%) marks = CGPA x 9.5
First Division with Distinction: CGPA is 8.00 or above
First Division: CGPA is 6.50 or above but below 8.00
Second Division: CGPA is 5.00 or above but below 6.50
Third Division: CGPA is 4.00 or above but below 5.00
Failed: CGPA is below 4.00

F. Duration for completion of the Programme will be "Duration of the Programme + 2 years".

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Programme Outcomes

After successful completion of the M.Sc. Physics programme, students will be able to:

1. Demonstrate comprehensive knowledge of fundamental and advanced concepts in theoretical and experimental Physics.
2. Apply mathematical, analytical and computational methods to formulate and solve complex problems in Physics.
3. Design, perform and analyse experiments using appropriate laboratory techniques, instrumentation and methods of data analysis.
4. Investigate scientific problems through critical analysis of literature, formulation of hypotheses, interpretation of data and evidence-based reasoning.
5. Use modern computational tools, programming techniques and scientific software for modelling, simulation, data analysis and visualization.
6. Communicate scientific concepts, methods and research findings effectively through written reports, oral presentations and scientific discussions.
7. Demonstrate ethical and responsible practices in experimentation, computation, research, data handling and scientific communication.
8. Engage in independent and lifelong learning and adapt acquired knowledge and skills to emerging areas of physics, interdisciplinary research and technological applications.

Programme Specific Outcomes

After successful completion of the M.Sc. Physics programme, Students will be able to:

1. Apply the principles of classical mechanics, electrodynamics, quantum mechanics, statistical mechanics, atomic and molecular physics, nuclear and particle physics, and condensed matter physics to analyse physical systems and solve advanced problems.
2. Perform and analyse experiments in areas such as optics, spectroscopy, electronics, condensed matter physics and related advanced laboratory domains using appropriate instrumentation and data-analysis techniques.
3. Employ computational and numerical methods, programming languages and scientific software to simulate physical systems, analyse experimental or observational data and solve physics problems.
4. Analyse and evaluate specialized problems in areas such as electronics, spectroscopy and condensed matter physics, and relate theoretical concepts to contemporary scientific and technological applications.
5. Formulate and conduct a supervised research project by reviewing scientific literature, collecting or generating data, applying suitable analysis methods, interpreting results and drawing scientifically justified conclusions.
6. Prepare and present scientific work in the form of dissertations, technical reports, seminars, conference presentations or research communications while adhering to accepted principles of research ethics and academic integrity.
7. Apply the knowledge of core concepts of physics to solve problems in competitive examinations such as NET, SET, and GATE.

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Programme: **M. Sc.**	Year: I	Semester: VII
Subject: **Physics**		
Course Code: **B010701T**	Course Title: **Mathematical Physics**	

Course Outcomes (COs)

After the completion of the course, students will be able to

1. Solve second-order linear differential equations using series-expansion methods and classify ordinary, regular singular, and singular points.
2. Analyze analytic functions and evaluate contour integrals using the Cauchy theorem, Cauchy integral formula, Laurent series, poles, and the residue theorem.
3. Apply the properties of Bessel, Legendre, Hermite, and Laguerre functions to solve mathematical problems arising in physics.
4. Apply Laplace and Fourier transforms to solve mathematical problems and interpret the corresponding inverse transforms.
5. Construct Green functions and apply Dirac-delta and Green-function methods to solve Poisson and inhomogeneous wave equations.

Credit: **4**	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical-Research (in hours per week): L-T-P-R: 3-1-0-0

Unit	Topics	**No. of Lectures**
I	Linear Differential Equations: Second order linear differential equations; Regular, regular singular and singular points; series expansion method.	9
II	Complex Analysis: Analytic functions, Cauchy-Riemann equations, Cauchy's theorem, Cauchy's Integral formula, Laurent series, Poles, Residue theorem, Evaluation of integrals.	9
III	Special Functions: Bessel, Legendre, Hermite and Laguerre differential equations with properties of their solutions.	9
IV	Integral transforms: Laplace transform, Fourier theorem, Fourier transforms.	9
V	Dirac delta function and Green function: Green function for Laplace operator, Solution of Poisson's equation, Inhomogeneous Wave equation and applications.	9

Suggested Readings

Textbooks:

i. Dass HK, "Mathematical Physics". S. Chand Publishing, 2017. 5th Edition.
ii. Ghatak AK, "Mathematical Physics". Trinity Press–Laxmi Publications, 1995. 1st Edition.
iii. Rajput BS, "Mathematical Physics". Prakashan Kendra.

Reference Books:

i. Spiegel MR, "Schaum's Outline of Complex Variables". McGraw-Hill.
ii. Kreyszig E, "Advanced Engineering Mathematics". Wiley.
iii. Arfken GB, Weber HJ, Harris FE, "Mathematical Methods for Physicists". Academic Press, 1995. 4th Edition.

Suggested Digital Platforms/Web Links

1. Swayam – Government of India, https://swayam.gov.in/explorer?category=Physics

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2. National Programme on Technology Enhanced Learning (NPTEL), https://nptel.ac.in/course.html 3. Uttar Pradesh Higher Education Digital Library, https://heecontent.upsdc.gov.in/SearchContent.aspx 4. MIT Open Learning – Massachusetts Institute of Technology, https://openlearning.mit.edu/ 5. edX, https://www.edx.org/course/subject/physics
Course Prerequisites
Physics as a major subject in B. Sc.

Programme: **M. Sc.**	Year: I	Semester: VII
Subject: **Physics**		
Course Code: **B010702T**	Course Title: **Classical Mechanics**	

Course Outcomes (COs)

After the completion of the course, students will be able to

1. Derive Lagrange's equations from variational principles and analyze conservation laws and symmetry properties of mechanical systems.
2. Formulate Hamiltonian equations of motion using Legendre transformations and solve systems involving cyclic coordinates.
3. Apply canonical transformations and Poisson brackets to analyze the dynamics of classical systems.
4. Solve Hamilton-Jacobi equations and relate the Hamilton-Jacobi formalism to geometrical optics and wave mechanics.
5. Analyze small oscillations using normal modes and frequencies, and formulate Lagrangian and Hamiltonian descriptions of classical fields.

Credit: **4**	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical-Research (in hours per week): L-T-P-R: 3-1-0-0

Unit	Topics	**No. of Lectures**
I	Variational Principles and Lagrange's Equations: Hamilton's principle, Calculus of variations, Lagrange's equations, Conservation Theorems and symmetry properties.	9
II	Hamiltonian formalism: Legendre transformations and the Hamiltonian Equations of Motion, Cyclic coordinates.	9
III	Canonical Transformations: Canonical transformations, Poisson Bracket	9
IV	Hamilton – Jacoby Theory: Hamiltonian Jacoby equations; Hamiltonian Jacoby theory, geometrical optics and wave mechanics	9
V	Small oscillations and normal modes: Small oscillations about a stable equilibrium, Normal modes and their frequencies, Langrangian and Hamiltonian formalism of Classical fields.	9

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Suggested Readings
Textbooks: I. H. Goldstein, C. Poole and J. Safko, Classical Mechanics, 3rd Edition, Pearson Education, India. II. Upadhyaya, J. C., Classical Mechanics, Himalaya Publishing House. **Reference Books** I. N. C. Rana and P. S. Joag, Classical Mechanics, Tata McGraw-Hill. II. Morin, David J., Introduction to Classical Mechanics: With Problems and Solutions, Cambridge University Press. III. Taylor JR, "Classical Mechanics". University Science Books, 2005. 1st Edition
Suggested Digital Platforms/Web Links
1. Swayam – Government of India, https://swayam.gov.in/explorer?category=Physics 2. National Programme on Technology Enhanced Learning (NPTEL), https://nptel.ac.in/course.html 3. Uttar Pradesh Higher Education Digital Library, https://heecontent.upsdc.gov.in/SearchContent.aspx 4. MIT Open Learning – Massachusetts Institute of Technology, https://openlearning.mit.edu/ 5. edX, https://www.edx.org/course/subject/physics
Course Prerequisites
Physics as a major subject in B. Sc.

Programme: **M. Sc.**	Year: I	Semester: VII
Subject: **Physics**		
Course Code: **B010703T**	Course Title: **Electrodynamics and Relativity**	
Course Outcomes (COs) After the completion of the course, students will be able to		
1. Apply tensor transformation laws, the metric tensor, index raising and lowering, and contraction to calculations in general coordinate systems. 2. Analyze Minkowski spacetime, light cones, causality, and the invariance and classification of Lorentz transformations. 3. Formulate electromagnetism covariantly using four-vectors, four-potentials, and the electromagnetic field tensor, and derive field transformations and invariants. 4. Solve the relativistic motion of charged particles in prescribed electromagnetic fields using the covariant Lorentz-force law. 5. Analyze transmission lines, rectangular-waveguide modes, and cavity resonators to determine their propagation characteristics and applications.		
Credit: **4**		Core Compulsory
Max. Marks: 25+75		Min. Passing Marks:
Total No. of Lectures-Tutorials-Practical-Research (in hours per week): L-T-P-R: 3-1-0-0		

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Unit	Topics	No. of Lectures
I	Tensor analysis: General coordinate transformation; contravariant, covariant and mixed tensors; metric tensor; raising and lowering of indices; contraction of indices; Pseudo-tensors.	9
II	Minkowsky space and Lorentz transformations: Geometry of space-time in Special Relativity; Minkowsky metric; Light cone and principle of causality; Invariance of Minkowsky metric under Lorentz transformations; Lorentz group; Proper, improper and orthochronous transformations.	9
III	Covariant formulation of electromagnetism: Charge-current density four-vector; Scalar and Vector potentials; Gauge invariance; Electromagnetic potential four-vector; Electromagnetic field tensor; Lorentz transformation of electric and magnetic fields; Invariants of the electromagnetic field.	9
IV	Electromagnetic field of a charge moving with constant velocity, Covariant form of Lorentz force law; Dynamics of charged particles in static and uniform electric fields.	8
V	Guided electromagnetic waves: Transmission Lines and Wave Guides, Modes in a rectangular wave guide, Cavity resonators.	10

Suggested Readings

Text Books:

I. Ram Kripal, Introduction to Electromagnetic Theory, 1st Edition, Booksclinic Publishing, 2021.
II. David J. Griffiths, Introduction to Electrodynamics, Cambridge University Press.
III. Wolfgang Rindler, Introduction to Special Relativity, Oxford University Press.
IV. David M. Pozar, Microwave Engineering, Wiley.

Reference Books:

I. Richard P. Feynman, Robert B. Leighton and Matthew Sands, The Feynman Lectures on Physics, Vol. II: Mainly Electromagnetism and Matter, Pearson Education India, 2012.
II. Murray R. Spiegel, Seymour Lipschutz and Dennis Spellman, Schaum's Outline of Vector Analysis, McGraw-Hill Education.
III. R. K. Pathria, The Theory of Relativity, Dover Publications.
IV. J. D. Jackson, Classical Electrodynamics, Wiley.

Suggested Digital Platforms/Web Links

1. Swayam – Government of India, https://swayam.gov.in/explorer?category=Physics
2. National Programme on Technology Enhanced Learning (NPTEL), https://nptel.ac.in/course.html
3. Uttar Pradesh Higher Education Digital Library, https://heecontent.upsdc.gov.in/SearchContent.aspx
4. MIT Open Learning – Massachusetts Institute of Technology, https://openlearning.mit.edu/
5. edX, https://www.edx.org/course/subject/physics

Course Prerequisites

Physics as a major subject in B. Sc.

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Programme: **M. Sc.**	Year: I	Semester: VII
Subject: **Physics**		
Course Code: **B010704T**	Course Title: **Quantum Mechanics I**	

Course Outcomes (COs)

After the completion of the course, students will be able to

1. Represent quantum states and observables in Hilbert space using Dirac notation and construct their matrix, coordinate, and momentum representations.
2. Apply the postulates of quantum measurement, commutators, and the uncertainty principle to calculate probabilities and uncertainties.
3. Compare the Schrodinger, Heisenberg, and Dirac representations and analyze the time evolution of quantum states.
4. Solve the harmonic-oscillator problem using matrix and operator methods and analyze its time development.
5. Apply spin and orbital angular-momentum algebra, combine angular momenta, and calculate Clebsch-Gordan coefficients for specified couplings.

Credit: **4**	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical-Research (in hours per week): L-T-P-R: 3-1-0-0

Unit	Topics	**No. of Lectures**
I	Hilbert space, Dirac's Bra-ket notations, observables as operators, projection operators, hermiticity of operators, orthonormality and completeness Relation, matrix representation of kets, bras and operators. wave-functions in coordinate and momentum representations.	12
II	Elementary ideas of measurement in quantum mechanics, commutators and Heisenberg uncertainty principle, general proof of uncertainty relation.	6
III	Time evolution of the system's state, Schrödinger, Heisenberg and Dirac representations.	9
IV	Matrix theory of harmonic oscillator, time development of harmonic oscillator.	9
V	Stern-Gerlach experiment and concept of spin, orbital angular momentum, commutation relations and angular momentum algebra, addition of angular momenta, Clebsch-Gordan coefficients, explicit addition of angular momentum 1/2 with angular momenta 1/2 and 1.	9

Suggested Readings

Textbooks:

I. Zettili, N. (2009). Quantum Mechanics: Concepts and Applications (2nd ed.). Wiley
II. Sakurai, J. J., & Napolitano, J. (2017). Modern Quantum Mechanics (2nd ed.). Cambridge University Press.
III. Rajput BS, "Advanced Quantum Mechanics". Pragati Prakashan.
IV. Griffiths DJ, Schroeter DF, "Introduction to Quantum Mechanics". Cambridge University Press, 2018. 3rd Edition

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Reference Books

I. Cohen-Tannoudji, C., Diu, B., & Laloe, F. (2005). Quantum Mechanics (Vols. I & II). Wiley-VCH.
II. Schiff, L. I. (1968). Quantum Mechanics (3rd ed.). McGraw-Hill
III. Dirac, P. A. M. (1958). The Principles of Quantum Mechanics (4th ed.). Oxford University Press.

Suggested Digital Platforms/Web Links

1. Swayam – Government of India, https://swayam.gov.in/explorer?category=Physics
2. National Programme on Technology Enhanced Learning (NPTEL), https://nptel.ac.in/course.html
3. Uttar Pradesh Higher Education Digital Library, https://heecontent.upsdc.gov.in/SearchContent.aspx
4. MIT Open Learning – Massachusetts Institute of Technology, https://openlearning.mit.edu/
5. edX, https://www.edx.org/course/subject/physics

Course Prerequisites

Physics as a major subject in B. Sc.

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Programme: **M. Sc.**	Year: I	Semester: VII
Subject: **Physics**		
Course Code: **B010705P**	Course Title: **General Lab**	

Course Outcomes (COs)

After the completion of the course, students will be able to

1. Perform experiments in optics, thermal physics, magnetism, semiconductors, and ultrasonics using appropriate laboratory instruments and procedures.
2. Analyze interference, diffraction, refraction, total internal reflection, and birefringence measurements to determine relevant optical parameters.
3. Determine physical and material parameters such as Stefan's constant, Curie temperature, magnetic response, semiconductor energy gap, and ultrasonic velocity.
4. Analyze absorption spectra, diffraction patterns, and Fourier-based measurements to extract physically meaningful quantities.
5. Evaluate experimental observations by comparing measured results with theoretical expectations and present the results systematically.

Credit: **4**	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical-Research (in hours per week): L-T-P-R: 0-0-8-0

List of Experiments

1. Concave Grating, Hg Source Arc
2. Optical Properties of Quartz
3. Cornu's fringes
4. Fabry-Perot Interferometer
5. Edser-Butler Fringes
6. Fresnel's Formula
7. Study of Total Internal Reflection
8. Curie Temperature
9. Quincke's Tube method
10. Iodine Absorption Spectra
11. Stefan's Constant
12. Ultrasonic Interferometer – Variation of velocity with temperature
13. Forbidden Energy Gap of semiconductors
14. Laser Intensity diffraction pattern of different objects
15. Fourier Analysis

Suggested Readings

Textbooks:

i. Ghatak A, "Optics". McGraw Hill Education, 2020. 7th Edition.
ii. Jenkins FA, White HE, "Fundamentals of Optics". McGraw Hill Education, 2017. 4th Edition.
iii. Fowles GR, "Introduction to Modern Optics". Dover Publications Inc., 1990. 2nd Edition.

Reference Books

i. Feynman RP, Leighton RB, Sands M, "The Feynman Lectures on Physics, Vol. II: Mainly Electromagnetism and Matter". Pearson Education India, 2012. New Millennium Edition.

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ii. Born M, Wolf E, "Principles of Optics". Cambridge University Press, 1999. 7th Edition.
iii. Taylor JR, "An Introduction to Error Analysis". University Science Books, 1997. 2nd Edition.
iv. Squires GL, "Practical Physics". Cambridge University Press, 1985. 3rd Edition.

Course Prerequisites

Physics as a major subject in B. Sc.

Programme: **M. Sc.**	Year: I	Semester: VII
Subject: **Physics**		
Course Code: **B010706P**	Course Title: **Electronics Lab**	

Course Outcomes (COs)

After the completion of the course, students will be able to

1. Measure and analyze the characteristics and parameters of semiconductor diodes, FETs, SCRs, and UJTs.
2. Design and evaluate common-emitter amplifier and negative-feedback circuits using measured gain and response characteristics.
3. Construct and analyze phase-shift, Hartley, tuned-collector, astable-multivibrator, and 555-timer circuits.
4. Implement amplitude modulation and demodulation and interpret the corresponding input and output waveforms.
5. Evaluate the performance of electronic circuits from experimental measurements and compare the results with theoretical predictions.

Credit: **4**	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical-Research (in hours per week): L-T-P-R: 0-0-8-0

List of Experiments

1. Band Gap of Ge and Si Diode
2. Negative Feedback
3. Modulation and Demodulation
4. Astable Multivibrator
5. 555 Timer IC
6. Field Effect Transistor (FET)
7. Silicon Controlled Rectifier (SCR)
8. Uni Junction Transistor (UJT)
9. Phase Shift Oscillator (PSO)
10. Hartley Oscillator
11. Tuned Collector Oscillator (TCO)
12. Design and Study of CE Amplifier

Suggested Readings

Textbooks:

i. Millman J, Halkias CS, "Electronic Devices and Circuits". McGraw-Hill Book Company.

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ii. Ryder JD, "Electronic Fundamentals and Applications". Prentice-Hall.
iii. Mehta VK, Mehta R, "Principles of Electronics". S. Chand Publishing.

Reference Books

I. Sze SM, Ng KK, "Physics of Semiconductor Devices". Wiley, 2006. 3rd Edition.
II. Sedra AS, Smith KC, "Microelectronic Circuits". Oxford University Press, 2015. 7th Edition.
III. Boylestad RL, Nashelsky L, "Electronic Devices and Circuit Theory". Pearson Education, 2013. 11th Edition.
IV. Malvino AP, Bates DJ, "Electronic Principles". McGraw-Hill Education, 2016. 8th Edition.

Course Prerequisites

Physics as a major subject in B. Sc.

Programme: **M. Sc.**	Year: I	Semester: VII
Subject: **Physics**		
Course Code: **B010708M**	Course Title: **Fundamentals of Physics**	

Course Outcomes (COs)

After the completion of the course, students will be able to

1. Explain the historical development of physics and classify physical phenomena in terms of characteristic length, time, and energy scales.
2. Apply Newtonian gravitation and Kepler's laws to planetary motion and compare Galilean relativity with Einstein's special relativity.
3. Analyze the failure of classical physics through blackbody radiation and the photoelectric effect, and explain uncertainty, wave-particle duality, and key quantum experiments.
4. Explain discrete energy levels, spin, elementary Schrodinger wave mechanics, and the relation between spin and statistics.
5. Compare Maxwell-Boltzmann, Bose-Einstein, and Fermi-Dirac statistics and classify elementary particles and fundamental interactions using their defining properties.

Credit: **4**	Minor Elective
Max. Marks: 25+75	Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical-Research (in hours per week): L-T-P-R: 3-1-0-0

Unit	Topics	**No. of Lectures**
I	Historical Development of Physics; Classification of physics in terms of Length scales, Time scales and Energy scales.	9
II	Evolution of universe and formation of stars. Newton's law of Gravitation; Planetary motion and Kepler's laws; Galilean relativity and concept of inertial frames. Einstein's theory of special relativity.	9
III	Failure of classical ideas with examples of blackbody spectrum and Photoelectric effect; Heisenberg's Uncertainty Principle; Wave-particle duality. Double-slit experiment, Stern-Gerlach experiment.	9
IV	Concepts of discrete energy levels and spin. Elementary ideas of Schrodinger's Wave mechanics. Relation between Spin and Statistics	9

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V	Bose-Einstein and Fermi-Dirac statistics, and Maxwell-Boltzmann statistics as classical limit. Elementary Particles (classification, quantum numbers) and Fundamental Interactions (classification, range, strength).	9

Suggested Readings

Textbooks:

I. Feynman RP, Leighton RB, Sands M, "The Feynman Lectures on Physics, Vol. I: Mainly Mechanics, Radiation, and Heat". Pearson Education India, 2012. New Millennium Edition.

II. Ling SJ, Moebs W, Sanny J, "University Physics, Vol. I, II & III". OpenStax, 2016.

III. Halliday D, Resnick R, Walker J, "Fundamentals of Physics". Wiley, 2018. 11th Edition.

Reference Books

IV. James I, "Remarkable Physics: From Galileo to Yukawa". Cambridge University Press, 2004

V. Tipler PA, Mosca G, "Physics for Scientists and Engineers". W. H. Freeman and Company, 2008. 6th Edition.

VI. Young HD, Freedman RA, "University Physics with Modern Physics". Pearson Education, 2019. 15th Edition.

Suggested Digital Platforms/Web Links

1. Swayam – Government of India, https://swayam.gov.in/explorer?category=Physics
2. National Programme on Technology Enhanced Learning (NPTEL), https://nptel.ac.in/course.html
3. Uttar Pradesh Higher Education Digital Library, https://heecontent.upsdc.gov.in/SearchContent.aspx

Course Prerequisites

Open to all.

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Programme: **M. Sc.**	Year: I	Semester: VIII
Subject: **Physics**		
Course Code: **B010801T**	Course Title: **Quantum Mechanics II**	

Course Outcomes (COs)

After the completion of the course, students will be able to

1. Apply time-independent perturbation theory, the variational method, and the WKB approximation to estimate eigenvalues and wavefunctions.
2. Apply time-dependent perturbation theory to calculate transition probabilities and use Fermi's Golden Rule for quantum transitions.
3. Analyze non-relativistic quantum scattering using phase shifts, partial waves, and the Born approximation.
4. Derive and analyze the Klein-Gordon and Dirac equations, including Dirac matrices, covariance, and bilinear covariants.
5. Solve the Klein-Gordon and Dirac equations for free particles and interpret negative-energy states, spin, and the position operator.

Credit: **4**	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical-Research (in hours per week): L-T-P-R: 3-1-0-0

Unit	Topics	**No. of Lectures**
I	Time-Independent Perturbation Theory and Applications, Variational Method, WKB Method.	9
II	Time-Dependent Perturbation Theory, Constant and Harmonic Perturbation, Transition probabilities, Fermi's Golden Rule.	9
III	Elementary theory of Scattering: Phase shifts, Method of partial waves, Born approximation.	9
IV	Klein Gordon Equation and Free Particle, Solution, Dirac Equation, Dirac Matrices, Covariance of Dirac Equation & Bilinear Covariant.	9
V	Solution for a Free Particle, Negative Energy states and Hole Theory, Spin, Position Operator.	9

Suggested Readings

Textbooks:

I. Zettili N, "Quantum Mechanics: Concepts and Applications". Wiley, 2009. 2nd Edition.
II. Griffiths DJ, Schroeter DF, "Introduction to Quantum Mechanics". Cambridge University Press, 2018. 3rd Edition.
III. Sakurai JJ, Napolitano J, "Advanced Quantum Mechanics". Addison-Wesley, 1967.

Reference Books

I. Walter Greiner, Relativistic Quantum Mechanics: Wave Equations, Springer.
II. James D. Bjorken and Sidney D. Drell, Relativistic Quantum Mechanics, McGraw-Hill
III. P. A. M. Dirac, The Principles of Quantum Mechanics, Oxford University Press.

Suggested Digital Platforms/Web Links

1. Swayam – Government of India, https://swayam.gov.in/explorer?category=Physics

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2. National Programme on Technology Enhanced Learning (NPTEL), https://nptel.ac.in/course.html
3. Uttar Pradesh Higher Education Digital Library, https://heecontent.upsdc.gov.in/SearchContent.aspx
4. MIT Open Learning – Massachusetts Institute of Technology, https://openlearning.mit.edu/

Course Prerequisites

Physics as a major subject in B. Sc.

Programme: **M. Sc.**	Year: I	Semester: VIII
Subject: **Physics**		
Course Code: **B010802T**	Course Title: **Statistical Mechanics**	

Course Outcomes (COs)

After the completion of the course, students will be able to

1. Analyze classical ensemble descriptions using Liouville's equation and calculate partition functions and fluctuations in canonical and grand-canonical ensembles.
2. Explain quantum ensemble theory and the density operator, and derive thermodynamic quantities for ideal systems using canonical and grand canonical ensembles.
3. Apply Fermi–Dirac and Bose–Einstein statistics to analyze quantum systems such as solids, Pauli paramagnetism, and degenerate quantum gases.
4. Analyze quantum statistical phenomena, including Bose–Einstein condensation, superfluidity in He II, and electrical conduction in metals, using appropriate statistical models.
5. Analyze non-equilibrium processes using stochastic approaches, including Langevin and Fokker–Planck equations, and apply fluctuation–dissipation theorems to relevant physical systems.

Credit: **4**	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical-Research (in hours per week): L-T-P-R: 3-1-0-0

Unit	Topics	**No. of Lectures**
I	A review of classical ensemble theory, Liouville's equations, Partition function and thermodynamic quantities of different systems such as Perfect Gas, Harmonic Oscillators. Fluctuation in energy in canonical ensemble and concentration in Grand Canonical ensemble.	9
II	Quantum Ensemble Theory: Density operator, Quantum Liouville's equation. Density operator for equilibrium microcanonical, canonical, and grand-canonical ensembles. Calculation of grand partition function and distribution function, Specific heat of solids. Pauli paramagnetism	10
III	Grand potential, FD and BE distribution in Grand Canonical ensemble Degenerate Bose Gas, Momentum Condensation, Liquid He II, Two fluid theory, Superfluidity.	9
IV	Degenerate FD Gas, Conduction Electrons in a Metal, Fluctuations, One dimensional Random walk, Gaussian Distribution.	7

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V	Random processes, Markoff process, Langevin Equation, Correlation functions, Fluctuations Dissipation Theorem, Weiner-Khintchine theorem, Nyquist theorem, Conditional probability, Fokker Plank Equation, Brownian motion.	10

Suggested Readings

Textbooks:

I. Reif F, "Fundamentals of Statistical and Thermal Physics". Levant Books, Kolkata, 2010.
II. Pathria R K, Beale P D, "Statistical Mechanics". Elsevier, Oxford, 2011. 3rd Edition.

Reference Books

I. Huang K, "Statistical Mechanics". Wiley India, Delhi, 2009. 2nd Edition.
II. Kardar M, "Statistical Physics of Particles". Cambridge University Press, Cambridge, 2007.
III. Landau LD, Lifshitz EM, "Statistical Physics". Part 1, Volume 5, Pergamon Press, New York, 1980.

Suggested Digital Platforms/Web Links

1. Swayam – Government of India, https://swayam.gov.in/explorer?category=Physics
2. National Programme on Technology Enhanced Learning (NPTEL), https://nptel.ac.in/course.html
3. Uttar Pradesh Higher Education Digital Library, https://heecontent.upsdc.gov.in/SearchContent.aspx
4. MIT Open Learning – Massachusetts Institute of Technology, https://openlearning.mit.edu/
5. edX, https://www.edx.org/course/subject/physics

Course Prerequisites

Physics as a major subject in B. Sc.

Programme: **M. Sc.**	Year: I	Semester: VIII
Subject: **Physics**		
Course Code: **B010803T**	Course Title: **Solid State Electronics**	

Course Outcomes (COs)

After the completion of the course, students will be able to

1. Analyze PN-junction rectifier, filter, regulator, and BJT h-parameter circuits and determine their low-frequency amplifier characteristics.
2. Analyze small-signal FET, multistage, and high-frequency BJT amplifiers and calculate their gain, phase, and frequency response.
3. Design and evaluate negative-feedback amplifiers and oscillators, and apply stability criteria to their operation.
4. Analyze large-signal power and radio-frequency amplifiers, including distortion and push-pull operation.
5. Explain and analyze frequency and phase modulation, demodulation, frequency changing, and tracking.

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Credit: 4		Core Compulsory
Max. Marks: 25+75		Min. Passing Marks:
Total No. of Lectures-Tutorials-Practical-Research (in hours per week): L-T-P-R: 3-1-0-0		
Unit	Topics	No. of Lectures
I	P-N Junction Diode: Rectifier with LC Filter, Electronic regulator. Bipolar Junction Transistors: h-parameters, inter conversion in different configurations, low frequency transistor amplifier.	9
II	Field Effect Transistors: Small signal model and dynamic parameters, CS and CD amplifiers. Multistage Amplifiers: BJT at high frequencies, frequency response of gain and phase shift, frequency response of RC coupled amplifier.	9
III	Feedback Amplifiers and Oscillators: Different negative feedback amplifiers, stability and Nyquist criteria, sinusoidal oscillators, phase shift and Wien's bridge oscillators, astable multivibrator.	9
IV	Power and Radio Frequency Amplifier: Large signal amplifier and distortions, Push-pull amplifier.	9
V	Modulation: Frequency and phase modulation, frequency modulation Demodulation: Frequency changing and tracking.	9

Suggested Readings

Textbooks:

I. Millman J, Halkias CS, "Electronic Devices and Circuits". McGraw-Hill.
II. Mehta VK, Mehta Rohit, "Principles of Electronics". S. Chand Publishing

Reference Books

I. Ryder JD, "Electronic Fundamentals and Applications". Prentice-Hall.
II. Sze SM, Ng KK, "Physics of Semiconductor Devices". Wiley. 3rd Edition.
III. Kumar J, Tiwari AK, Singh D, "Electronic Devices and Circuits". Narosa Publishing House, 2015

Suggested Digital Platforms/Web Links

1. Swayam – Government of India, https://swayam.gov.in/explorer?category=Physics
2. National Programme on Technology Enhanced Learning (NPTEL), https://nptel.ac.in/course.html
3. Uttar Pradesh Higher Education Digital Library, https://heecontent.upsdc.gov.in/SearchContent.aspx
4. MIT Open Learning – Massachusetts Institute of Technology, https://openlearning.mit.edu/
5. edX, https://www.edx.org/course/subject/physics

Course Prerequisites

Physics as a major subject in B. Sc.

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Programme: **M. Sc.**	Year: I	Semester: VIII
Subject: **Physics**		
Course Code: **B010804T**	Course Title: **Atomic and Molecular Physics**	

Course Outcomes (COs)

After the completion of the course, students will be able to

1. Analyze the spectra of hydrogen, helium, and alkali atoms and interpret their energy-level structures and spectral series.
2. Determine spectroscopic terms using LS and JJ coupling and analyze linewidth, X-ray spectra, and hyperfine structure.
3. Analyze Zeeman, Paschen-Back, and Stark splittings and interpret the principles and spectral information obtained from ESR and NMR.
4. Apply rigid/non-rigid rotator and harmonic/anharmonic oscillator models to rotational and vibrational spectra of diatomic molecules, including isotopic effects.
5. Analyze Raman spectra and the vibrational and fine structure of electronic band systems, including their intensity distributions.

Credit: **4**	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical-Research (in hours per week): L-T-P-R: 3-1-0-0

Unit	Topics	**No. of Lectures**
I	Quantum states of an electron in an atom, Spectrum of Hydrogen and Helium atom, fine structure Spectra of Alkali atoms; energy level diagrams, Sharp, Principal, Diffuse and fundamental series.	9
II	Width of spectral lines, X-ray spectroscopy, Spectroscopic terms; LS & JJ couplings, Hyperfine structure	9
III	Zeeman, Paschen Back & Stark effect, Electron spin resonance, Nuclear magnetic resonance, chemical shift	9
IV	Spectra of Diatomic Molecules Rotational Spectra (rigid rotator and non-rigid rotator model) Vibrational Spectra (harmonic and enharmonic model) Molecular Symmetric Top, Vibrating rotator Isotopic shift	9
V	Raman Spectra (Quantum mechanical and classical approach) Electronic Spectra-vibrational structure of band system, fine structure of the band systems. Intensity distribution in band systems	9

Suggested Readings

Textbooks:

i. E. White, Introduction to Atomic Spectra, McGraw-Hill Book Company.
ii. C. N. Banwell and E. M. McCash, Fundamentals of Molecular Spectroscopy, 4th Edition, McGraw-Hill Education.
iii. Rajkumar, Atomic and Molecular Spectra, KNRN Publishing House, Meerut.

Reference Books

i. Demtröder, W., Molecular Physics: Theoretical Principles and Experimental Methods, Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, 2005.
ii. C. J. Foot, Atomic Physics, Oxford University Press

Suggested Digital Platforms/Web Links

1. Swayam – Government of India, https://onlinecourses.nptel.ac.in/noc25_ph04/preview

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		19/09/26		11.9.26

2. National Programme on Technology Enhanced Learning (NPTEL), https://nptel.ac.in/course.html 3. Uttar Pradesh Higher Education Digital Library, https://heecontent.upsdc.gov.in/SearchContent.aspx 4. MIT Open Learning – Massachusetts Institute of Technology, https://openlearning.mit.edu/ 5. edX, https://www.edx.org/course/subject/physics
Course Prerequisites
Physics as a major subject in B. Sc.

Dr. Alok K. Verma (Internal Member)

Prof. P. K. Yadawa (Internal Member)

Prof. Devraj Singh (Internal Member)

Dr. Anil K Yadav (External Expert)

Prof. Giridhar Mishra (Convener)

Programme: **M. Sc.**	Year: I	Semester: VIII
Subject: **Physics**		
Course Code: **B010805P**	Course Title: **Electronics Lab**	

Course Outcomes (COs)

After the completion of the course, students will be able to

1. Measure and analyze the characteristics and parameters of semiconductor diodes, FETs, SCRs, and UJTs.
2. Design and evaluate common-emitter amplifier and negative-feedback circuits using measured gain and response characteristics.
3. Construct and analyze phase-shift, Hartley, tuned-collector, astable-multivibrator, and 555-timer circuits.
4. Implement amplitude modulation and demodulation and interpret the corresponding input and output waveforms.
5. Evaluate the performance of electronic circuits from experimental measurements and compare the results with theoretical predictions.

Credit: **4**	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical-Research (in hours per week): L-T-P-R: 0-0-8-0

List of Experiments

1. Band Gap of Ge and Si Diode
2. Negative Feedback
3. Modulation and Demodulation
4. Astable Multivibrator
5. 555 Timer IC
6. Field Effect Transistor (FET)
7. Silicon Controlled Rectifier (SCR)
8. Uni Junction Transistor (UJT)
9. Phase Shift Oscillator (PSO)
10. Hartley Oscillator
11. Tuned Collector Oscillator (TSO)
12. Design and Study of CE Amplifier

Suggested Readings

Textbooks:

I. Millman J, Halkias CS, "Electronic Devices and Circuits". McGraw-Hill.
II. Boylestad RL, Nashelsky L, "Electronic Devices and Circuit Theory". Pearson.

Reference Books

I. Ryder JD, "Electronic Fundamentals and Applications". Prentice-Hall.
II. Sze SM, Ng KK, "Physics of Semiconductor Devices". Wiley. 3rd Edition.
III. Kumar J, Tiwari AK, Singh D, "Electronic Devices and Circuits". Narosa Publishing House, 2015.
IV. Malvino AP, Bates DA, "Electronic Principles". McGraw-Hill.

Course Prerequisites

Physics as a major subject in B. Sc.

Dr. Alok K. Verma (Internal Member) | Prof. P.K. Yadawa (Internal Member) | Prof. Devraj Singh (Internal Member) | Dr. Anil K Yadav (External Expert) | Prof. Giridhar Mishra (Convener)

Programme: **M. Sc.**	Year: I	Semester: VIII
Subject: **Physics**		
Course Code: **B010806P**	Course Title: **General Lab**	

Course Outcomes (COs)

After the completion of the course, students will be able to

1. Perform experiments in optics, thermal physics, magnetism, semiconductors, and ultrasonics using appropriate laboratory instruments and procedures.
2. Analyze interference, diffraction, refraction, total internal reflection, and birefringence measurements to determine relevant optical parameters.
3. Determine physical and material parameters such as Stefan's constant, Curie temperature, magnetic response, semiconductor energy gap, and ultrasonic velocity.
4. Analyze absorption spectra, diffraction patterns, and Fourier-based measurements to extract physically meaningful quantities.
5. Evaluate experimental observations by comparing measured results with theoretical expectations and present the results systematically.

Credit: **4**	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical-Research (in hours per week): L-T-P-R: 0-0-8-0

List of Experiments

1. Concave Grating, Hg Source Arc
2. Optical Properties of Quartz
3. Cornu's fringes
4. Fabry-Perot Interferometer
5. Edser-Butler Fringes
6. Fresnel's Formula
7. Study of Total Internal Reflection
8. Curie Temperature
9. Quincke's Tube method
10. Iodine Absorption Spectra
11. Stefan's Constant
12. Ultrasonic Interferometer – Variation of velocity with temperature
13. Forbidden Energy Gap of semiconductors
14. Laser Intensity diffraction pattern of different objects
15. Fourier Analysis

Suggested Readings

Textbooks:

I. Ghatak A, "Optics". McGraw Hill, 2020.
II. Jenkins FA, White HE, "Fundamentals of Optics". McGraw Hill Education, 2017

Reference Books

I. Fowles GR, "Introduction to Modern Optics". Dover Publications, 1990.
II. Feynman RP, Leighton RB, Sands M, "The Feynman Lectures on Physics, Vol. II: Mainly Electromagnetism and Matter". Pearson Education India, 2012.

Course Prerequisites

Physics as a major subject in B. Sc.

Dr. Alok K. Verma (Internal Member) | Prof. P. K. Yadawa (Internal Member) | Prof. Devraj Singh (Internal Member) | Dr. Anil K. Yadav (External Expert) | Prof. Giridhar Mishra (Convener)

Programme: **M. Sc.**	Year: I	Semester: VIII
Subject: **Physics**		
Course Code: **B010807R**	Course Title: **Dissertation: Literature Survey and Data Collection**	

Course Outcomes (COs)

After the completion of the course, students will be able to

1. Identify and critically review relevant literature and collect, organize, and document appropriate data from experiments, surveys, or data repositories for the selected research problem.
2. Select suitable data-acquisition methods and sources according to the objectives and requirements of the research problem.
3. Evaluate the quality, completeness, reliability, and relevance of the collected data before subsequent analysis.
4. Organize the literature and collected data in a traceable form with appropriate documentation and source attribution.

Credit: **4**	Core Compulsory
Max. Marks: 100	Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical-Research (in hours per week): L-T-P-R: 0-0-0-8

	Topics
	Data Collection on the Problem

Suggested Readings

Textbooks:

I. Creswell JW, "Research Design: Qualitative, Quantitative, and Mixed Methods Approaches". SAGE Publications, 2014.

II. Booth WC, Colomb GG, Williams JM, Fitzgerald W, "The Craft of Research". University of Chicago Press, 2008.

Reference Books

As per the field and specific research area of the dissertation project.

Suggested Digital Platforms/Web Links

1. Google Scholar (https://scholar.google.com/)
2. ScienceDirect (https://www.sciencedirect.com/)
3. Scopus (https://www.elsevier.com/en-in/solutions/scopus)
4. Web of Science (http://webofscience.com/wos/woscc/basic-search)

Course Prerequisites

Physics as a major subject in B. Sc.

11.09.26

Dr. Alok K. Verma (Internal Member) | Prof. P. K. Yadawa (Internal Member) | Prof. Devraj Singh (Internal Member) | Dr. Anil K Yadav (External Expert) | Prof. Giridhar Mishra (Convener)

Programme: **M. Sc.**	Year: I	Semester: VIII
Subject: **Physics**		
Course Code: **B010808M**	Course Title: **Frontiers in Physics**	

Course Outcomes (COs)

After the completion of the course, students will be able to

1. Explain major ideas at the frontiers of physics, including relativity, black holes, neutrinos, gravitational waves, dark matter, and related modern concepts.
2. Analyze the principles, applications, and societal implications of nanotechnology in medicine, electronics, green technology, and other emerging areas.
3. Explain fundamental quantum concepts and evaluate emerging applications such as quantum computation and quantum biology.
4. Analyze the physical mechanisms of climate change, including atmospheric structure, ozone, greenhouse gases, and carbon footprints.
5. Evaluate renewable and clean-energy options and propose physics-based approaches that support sustainable development.

Credit: **4**	Minor Elective
Max. Marks: 25+75	Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical-Research (in hours per week): L-T-P-R: 3-1-0-0

Unit	Topics	**No. of Lectures**
I	Space and Time, Einstein's Special and General Relativity, Unified reality, Does time flow? Strings and all that, The elegant universe, Black holes, neutrinos, gravitational waves, dark matter.	9
II	Basics of Nanotechnology, Application in medicine, Nano-therapy for combating cancer, green nanotechnology. Multi-dimensional impact of nanotechnology on health, nanotechnology in warfare, nano art, nano electronics, nano bots.	9
III	The quantum world, Basic idea of probability, concept of continuous and discrete, quantum healing, quantum computation, quantum biology, QUBITS the new buzzword.	9
IV	The Physics of climate change, structure of the atmosphere, composition of the earth's atmosphere, the ozone problem, greenhouse gases, carbon footprints and how to minimize them, factors controlling climate.	9
V	Sustainable development and clean energy, renewable energy sources: solar cells, wind and hydropower; nuclear fusion.	9

Suggested Readings

Textbooks:

I. Lincoln D, "Understanding the Universe: From Quarks to the Cosmos". World Scientific Publishing Co. Pte. Ltd., 2012.
II. Schaefer HE, "Nanoscience: The Science of the Small in Physics, Engineering, Chemistry, Biology and Medicine". Springer, 2010

Reference Books

I. Ford KW, "The Quantum World: Quantum Physics for Everyone". Harvard University Press, 2004.

11.09.26

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II. Schilling G, Rees M, "Ripples in Spacetime – Einstein, Gravitational Waves, and the Future of Astronomy". Harvard University Press, 2017.
III. Wolf EL, "Physics and Technology of Sustainable Energy". Oxford University Press, 2018

Suggested Digital Platforms/Web Links

1. Swayam – Government of India, https://swayam.gov.in/explorer?category=Physics
2. National Programme on Technology Enhanced Learning (NPTEL), https://nptel.ac.in/course.html
3. Uttar Pradesh Higher Education Digital Library, https://heecontent.upsdc.gov.in/SearchContent.aspx
4. MIT Open Learning – Massachusetts Institute of Technology, https://openlearning.mit.edu/
5. edX, https://www.edx.org/course/subject/physics

Course Prerequisites

Open to all.

Dr. Alok K. Verma (Internal Member) | Prof. P. K. Yadawa (Internal Member) | Prof. Devraj Singh (Internal Member) | Dr. Anil K Yadav (External Expert) | Prof. Giridhar Mishra (Convener)

Programme: **M. Sc.**	Year: II	Semester: IX
Subject: **Physics**		
Course Code: **B010901T**	Course Title: **Solid State Physics**	

Course Outcomes (COs)

After the completion of the course, students will be able to

1. Analyze electron-band models, extrinsic semiconductors, and Fermi surfaces, including the physical basis of the de Haas-van Alphen effect.
2. Explain superconducting phenomena and apply BCS, energy-gap, tunnelling, Josephson, and high-Tc concepts to compare superconducting materials.
3. Analyze dielectric response and lattice modes in ionic crystals and explain ordered phases, quasicrystals, and conducting polymers.
4. Calculate equilibrium point-defect concentrations and analyze Frenkel and Schottky defects, colour centres, dislocations, and Burgers vectors.
5. Compare classical and quantum models of magnetism and analyze diamagnetism, paramagnetism, ferromagnetism, and the temperature dependence of magnetization.

Credit: **4**	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical-Research (in hours per week): L-T-P-R: 3-1-0-0

Unit	Topics	**No. of Lectures**
I	Electron band theory: one electron band theories. Plane wave like and localized wave functions. Nearly free electron approximation. Elementary discussion of orthogonalized Plane Wave (OPW) and Pseudo potential methods, Variation of Fermi energy in extrinsic semiconductors, de-Hass-van Alphen effect experiment to investigate Fermi surface.	9
II	Superconductivity: Meissner effect, isotope effect, type I and II superconductors. Cooper pairs. Elementary ideas of BCS theory, Approximate estimate of transition temperature, superconducting energy gap, Measurement of energy gap by infrared absorption and electron tunnelling methods, Elementary ideas about Josephson effect and high Tc superconductors.	9
III	Ionic lattice in presence of infrared field, dielectric constant, L.S.T. relation, LO and TO modes, ordered phases of matter, translational and orientational order, Quasicrystals, conducting polymers.	9
IV	Lattice defects: Frenkel and Schottky defects, colour centres, number of defects (vacancies) in equilibrium, Dislocations, edge and screw Burgers vector.	9
V	Diamagnetism, Langevin diamagnetic equation, Quantum theory of para magnetism rare earth ions and iron group ions. Ferromagnetism, Curie temperature, Heisenberg model, Temperature dependence of saturated magnetization.	9

Suggested Readings

Dr. Alok K. Verma (Internal Member)	Prof. P. K. Yadawa (Internal Member)	Prof. Devraj Singh (Internal Member)	Dr. Anil K Yadav (External Expert)	Prof. Giridhar Mishra (Convener)

Textbooks:

I. Kittel C, "Introduction to Solid State Physics". John Wiley & Sons, Inc., New Jersey, USA, 2012. 8th Edition.

II. Ashcroft NW, Mermin ND, "Solid State Physics". Holt, Rinehart and Winston, 1976

Reference Books

I. Dekker AJ, "Solid State Physics". McMillan India, 2000.

II. Simon SH, "The Oxford Solid State Basics". Oxford University Press, Oxford, UK, 2013. 1st Edition

Suggested Digital Platforms/Web Links

1. Swayam – Government of India, https://swayam.gov.in/explorer?category=Physics
2. National Programme on Technology Enhanced Learning (NPTEL), https://nptel.ac.in/course.html
3. Uttar Pradesh Higher Education Digital Library, https://heecontent.upsdc.gov.in/SearchContent.aspx
4. MIT Open Learning – Massachusetts Institute of Technology, https://openlearning.mit.edu/
5. edX, https://www.edx.org/course/subject/physics

Course Prerequisites

Physics in M. Sc. I Year.

Programme: **M. Sc.**	Year: II	Semester: IX
Subject: **Physics**		
Course Code: **B010902T**	Course Title: **Nuclear and Particle Physics**	

Course Outcomes (COs)

After the completion of the course, students will be able to

1. Analyze the deuteron and nucleon-nucleon scattering to evaluate the basic properties and charge symmetry of nuclear forces.
2. Apply shell and collective models to predict nuclear spin-parity, angular momentum, magnetic and quadrupole moments, and nuclear isomerism.
3. Analyze compound, direct, heavy-ion, and relativistic nuclear reactions using appropriate reaction models and kinematics.
4. Classify elementary particles and interactions and evaluate particle reactions using conservation laws, isospin, strangeness, discrete symmetries, SU(3), and the quark model.
5. Analyze alpha, beta, and gamma decay processes and apply the associated conservation principles and selection rules.

Credit: **4**	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical-Research (in hours per week): L-T-P-R: 3-1-0-0

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Unit	Topics	No. of Lectures
I	Deuteron, n-n scattering, n-p scattering, p-p scattering, charge symmetry of nuclear forces.	9
II	Shell Model, Extreme Single particle picture and angular momentum, magnetic moment, quadrupole moment of nuclei, Nuclear Isomerism, Collective model (qualitative discussion)	9
III	Compound Nucleus, Breit-Wigner Formula, Direct Interaction, Heavy Ion Reactions, Relativistic Kinematics	9
IV	Fundamental types of Interactions, General Classifications of Elementary Particles, Isospin, Strangeness, Conservation Laws, Symmetries (C, CP, CPT), SU(3) and quark model	9
V	Alpha, beta and gamma decay	9

Suggested Readings

Textbooks:

I. Devanathan, "Nuclear Physics". Narosa Publishing House.
II. Krane KS, "Introductory Nuclear Physics". John Wiley & Sons.
III. Griffiths DJ, "Introduction to Elementary Particles". Wiley-VCH.
IV. Martin BR, "Nuclear and Particle Physics: An Introduction". John Wiley & Sons.

Reference Books

I. Wong SSM, "Introductory Nuclear Physics". Wiley-VCH.
II. Povh B, Rith K, Scholz C, Zetsche F, "Particles and Nuclei: An Introduction to the Physical Concepts". Springer.
III. Blatt JM, Weisskopf VF, "Theoretical Nuclear Physics". Springer.
IV. Roy RR, Nigam BP, "Nuclear Physics: Theory and Experiment". New Age International

Suggested Digital Platforms/Web Links

1. Swayam – Government of India, https://swayam.gov.in/explorer?category=Physics
2. National Programme on Technology Enhanced Learning (NPTEL), https://nptel.ac.in/course.html
3. Uttar Pradesh Higher Education Digital Library, https://heecontent.upsdc.gov.in/SearchContent.aspx
4. MIT Open Learning – Massachusetts Institute of Technology, https://openlearning.mit.edu/
5. edX, https://www.edx.org/course/subject/physics

Course Prerequisites

Physics in M. Sc. I Year.

Programme: **M. Sc.**	Year: II	Semester: IX
Subject: **Physics**		
Course Code: **B010903T**	Course Title: **Analog and Digital Electronics**	

Course Outcomes (COs)

After the completion of the course, students will be able to

1. Measure and analyze operational-amplifier parameters such as CMRR, slew rate, offset voltage and current, and temperature drift.

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2. Design and analyze linear op-amp circuits including amplifiers, adders, converters, followers, integrators, differentiators, and active Butterworth filters.
3. Analyze non-linear analog circuits including sample-and-hold circuits, comparators, Schmitt triggers, log/antilog amplifiers, clippers, and clampers.
4. Design and analyze sequential digital circuits using flip-flops, shift registers, and asynchronous and synchronous counters.
5. Analyze wide-band BJT amplifiers using the hybrid-pi model and evaluate their low- and high-frequency response and compensation.

Credit: **4**	Specialization I
Max. Marks: 25+75	Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical-Research (in hours per week): L-T-P-R: 3-1-0-0

Unit	Topics	No. of Lectures
I	Operational Amplifier: Ideal op-amp, CMRR, Slew Rate, Offset error voltage and current and there balancing circuits. Temperature drifts, measurement of op-amp parameters.	9
II	Op-amp Applications: Inverter, Scale changer, adder, voltage to current converter, current to voltage converter, voltage follower, Analog integration and differentiation, solution of simultaneous and differential equations, Active Butterworth filter.	9
III	Non-linear Analog System: Sample and hold circuits, Comparators, Zero-crossing Detector, Schmitt Trigger (regenerative comparator), log and antilog amplifiers, Clippers and Clampers.	9
IV	Digital Electronics: Flip Flop; SR, JK, Master-slave, Registers and counters; Shift Register, ripple counter, up down asynchronous and synchronous counters, ring counter.	9
V	Wide band amplifier: Review of BJT at high frequencies. Hybrid pi equivalent model, Junction capacitance. Effect of an emitter bypass capacitor on low frequency response. High and low frequency compensations.	9

Suggested Readings

Textbooks:

I. Millman J, Halkias CC, Parikh CD, "Integrated Electronics: Analog and Digital Circuits and Systems". McGraw Hill Education, New Delhi, 2010. 2nd Edition.
II. Taub H, Schilling D, "Pulse, Digital, and Switching Waveforms" McGraw-Hill, New York, 1965.
III. Gayakwad RA, "Op-Amps and Linear Integrated Circuits". Prentice Hall of India, New Delhi, 2008. 4th Edition.

Reference Books

IV. Choudhury DR, Jain SB, "Linear Integrated Circuits".
V. R. P. Jain, "Modern Digital Electronics: An Introduction to Theory and Practice". Tata McGraw-Hill, New Delhi, 2009. 4th Edition.

Suggested Digital Platforms/Web Links

1. Swayam – Government of India, https://swayam.gov.in/explorer?category=Physics

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2. National Programme on Technology Enhanced Learning (NPTEL), https://nptel.ac.in/course.html 3. Uttar Pradesh Higher Education Digital Library, https://heecontent.upsdc.gov.in/SearchContent.aspx 4. MIT Open Learning – Massachusetts Institute of Technology, https://openlearning.mit.edu/ 5. edX, https://www.edx.org/course/subject/physics
Course Prerequisites
Physics in M.Sc. 1st year

Programme: **M. Sc.**	Year: II	Semester: IX
Subject: **Physics**		
Course Code: **B010904T**	Course Title: **Microwaves**	

Course Outcomes (COs)

After the completion of the course, students will be able to

1. Apply transmission-line and waveguide theory, impedance matching, and the Smith chart to analyze rectangular and circular waveguides and cavity resonators.
2. Construct and analyze scattering matrices for passive microwave components and evaluate their transmission and coupling characteristics.
3. Analyze klystron and reflex-klystron operation in terms of velocity modulation, bunching, tuning, power, and efficiency.
4. Analyze magnetron and travelling-wave-tube operation, including oscillation modes, electron-beam dynamics, coupling, and output power.
5. Perform and interpret microwave measurements of VSWR, frequency, wavelength, power, and dielectric properties and evaluate material-processing applications.

Credit: **4**	Specialization I
Max. Marks: 25+75	Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical-Research (in hours per week): L-T-P-R: 3-1-0-0

Unit	Topics	**No. of Lectures**
I	Introduction of microwaves, transmission line analysis, impedance matching, Smith chart, Waveguides (WG): wave equation, rectangular and circular WG, and cavity resonator.	9
II	Passive microwave devices: Scattering Matrix, Microwave Hybrid Circuits, Terminations, Attenuators, Phase Shifters, Directional Couplers, Isolators, Circulators, S-parameter analysis of all components.	9
III	Vacuum Tube Microwave Generators: Velocity modulation and density modulation, small signal theory of bunching, two cavity klystron amplifier, and Oscillator, Reflex klystron: Theory of bunching, optimum power, effect of repeller voltage, electronic admittance, efficiency, electronic tuning.	9
IV	Magnetron: Travelling wave magnetron, modes of oscillations, output power, travelling wave tube: Description, dynamic of electron beam, coupling of beam and slow wave structure.	9

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V	Detection of microwaves, measurement of microwaves, measurement of VSWR, frequency, wavelength, microwave power, dielectric properties of materials, Applications of microwaves in material processing.	9

Suggested Readings

Textbooks:

I. Chaturvedi PK, "Microwave, Radar and R.F. Engineering", Springer, 2018.
II. Gupta KC, "Microwaves", New age international, New Delhi, 2017.
III. Dube DC, "Microwave devices and applications", Narosa, 2011.

Reference Books

I. Liao SY, "Microwave Devices and Circuits". Pearson Education, 3rd Edition.
II. Collins RE, "Foundations for Microwave Engineering". John Wiley & Sons, 2nd Edition
III. Atwater HA, "Introduction to Microwave Theory". McGraw-Hill Publishing Co., 1962.
IV. Dube DC, "Microwave Devices and Applications". Narosa Publishing House, New Delhi, 2011

Suggested Digital Platforms/Web Links

1. Swayam – Government of India, https://swayam.gov.in/explorer?category=Physics
2. National Programme on Technology Enhanced Learning (NPTEL), https://nptel.ac.in/course.html
3. Uttar Pradesh Higher Education Digital Library, https://heecontent.upsdc.gov.in/SearchContent.aspx
4. MIT Open Learning – Massachusetts Institute of Technology, https://openlearning.mit.edu/
5. edX, https://www.edx.org/course/subject/physics

Course Prerequisites

Physics in M.Sc. 1st year

Programme: **M. Sc.**	Year: II	Semester: IX
Subject: **Physics**		
Course Code: **B010905T**	Course Title: **Laser Spectroscopy**	

Course Outcomes (COs)

After the completion of the course, students will be able to

1. Compare spectroscopic light sources, thermal and photo detectors, optical multichannel analyzers, CCDs, and ICCDs for experimental applications.
2. Explain the operating principles and characteristics of fixed-frequency and tunable lasers including YAG, argon-ion, excimer, dye, and semiconductor lasers.
3. Analyze laser photoacoustic, laser-induced-fluorescence, and laser optogalvanic spectroscopic techniques and select suitable methods for specific measurements.
4. Analyze laser Raman techniques including CARS, SRS, and SERS and interpret the role of time-resolved spectroscopy.
5. Evaluate Fourier-transform spectroscopy, laser isotope separation, and medical applications of lasers.

Credit: **4**	Specialization II

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Max. Marks: 25+75		Min. Passing Marks:
Total No. of Lectures-Tutorials-Practical-Research (in hours per week): L-T-P-R: 3-1-0-0		
Unit	Topics	**No. of Lectures**
I	Light Sources (Arc, Spark, Discharge, Beam Foil etc.), Synchrotron, Laser, Thermal and Direct Photo Detectors, Optical Multichannel Analyzer, Charged Coupled Devices (CCD), Integrated Charged Coupled Devices (ICCD).	9
II	Fixed-frequency and Tuneable lasers, YAG, Argon Ion, Excimer, Dye, Semiconductor Lasers	9
III	Laser Photoacoustic Spectroscopy, Laser Induced Fluorescence (LIF), Laser Optogalvanic Spectroscopy	9
IV	Laser Raman Spectroscopy (CARS, SRS, SERS), Time Resolved Spectroscopy	9
V	Fourier Transform Spectroscopy, Laser Isotope Separation, Medical Applications of Laser.	9

Suggested Readings

Textbooks:

I. Svelto O, "Principles of Lasers". Springer, 5th Edition.
II. Thyagarajan K, Ghatak A, "Lasers: Fundamentals and Applications". Springer.
III. Demtröder W, "Laser Spectroscopy and Instrumentation". Springer.

Reference Books

I. Laud BB, "Lasers and Nonlinear Optics". New Age International Publishers.
II. Thakur SN, Rai DK, "Atom, Laser and Spectroscopy". 2nd Edition.
III. Lakowicz JR, "Principles of Fluorescence Spectroscopy".

Suggested Digital Platforms/Web Links

1. Swayam – Government of India, https://swayam.gov.in/explorer?category=Physics
2. National Programme on Technology Enhanced Learning (NPTEL), https://nptel.ac.in/course.html
3. Uttar Pradesh Higher Education Digital Library, https://heecontent.upsdc.gov.in/SearchContent.aspx
4. MIT Open Learning – Massachusetts Institute of Technology, https://openlearning.mit.edu/
5. edX, https://www.edx.org/course/subject/physics

Course Prerequisites

Physics in M.Sc. 1st year

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Prof. P. K. Yadawa (Internal Member)
Prof. Devraj Singh (Internal Member) 11-09-26
Dr. Anil K Yadav (External Expert)
Prof. Giridhar Mishra (Convener) 11.9.26

Programme: **M. Sc.**	Year: II	Semester: IX
Subject: **Physics**		
Course Code: **B010906T**	Course Title: **Electronic Spectra of Diatomic Molecules**	

Course Outcomes (COs)

After the completion of the course, students will be able to

1. Analyze electronic spectra of diatomic molecules using the Deslandres table and the Franck-Condon principle.
2. Analyze the symmetry of rotational levels, nuclear-spin effects, intensity alternation, and molecular-band intensities.
3. Classify molecular states and apply coupling schemes and selection rules to electronic transitions.
4. Construct electronic configurations of diatomic molecules using building-up principles and molecular-orbital theory.
5. Analyze continuous and diffuse spectra and predissociation, and determine dissociation energies of selected diatomic molecules.

Credit: **4**	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical-Research (in hours per week): L-T-P-R: 3-1-0-0

Unit	Topics	**No. of Lectures**
I	Review of electronic spectra of diatomic molecules, Deslander's table, Franck Condom Principle	9
II	Symmetry properties of rotational levels for di-atomic molecule, Intensity of molecular band in electronic spectra. Nuclear spin and Intensity alternation in electronic band structure.	9
III	Classification of Molecular States, Multiplet Structure, Coupling and Uncoupling phenomena, Selection Rules for Electronic Transitions,	9
IV	Building up Principles. Electronic Configuration in diatomic molecule, Molecular Orbital Theory.	9
V	Continuous and diffused spectra, Pre-dissociation, Determination of dissociation energy of O_2, I_2 and N_2 molecules	9

Suggested Readings

Textbooks:

i. C. N. Banwell and E. M. McCash, Fundamentals of Molecular Spectroscopy, 4th Edition, McGraw-Hill Education.
ii. Rajkumar, Atomic and Molecular Spectra, KNRN Publishing House, Meerut.
iii. P. F. Bernath, Spectra of Atoms and Molecules, Oxford University Press.

Reference Books

i. G. Herzberg, Molecular Spectra and Molecular Structure, Vol. I: Spectra of Diatomic Molecules, Van Nostrand Reinhold.

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ii. Aruldhas, G., Molecular Structure and Spectroscopy, Prentice-Hall of India (PHI) Learning Pvt. Ltd.
iii. P. F. Bernath, Spectra of Atoms and Molecules, Oxford University Press.

Suggested Digital Platforms/Web Links

1. Swayam – Government of India, https://swayam.gov.in/explorer?category=Physics
2. National Programme on Technology Enhanced Learning (NPTEL), https://nptel.ac.in/course.html
3. Uttar Pradesh Higher Education Digital Library, https://heecontent.upsdc.gov.in/SearchContent.aspx
4. MIT Open Learning – Massachusetts Institute of Technology, https://openlearning.mit.edu/
5. edX, https://www.edx.org/course/subject/physics

Course Prerequisites

Physics in M.Sc. 1st year

Programme: **M. Sc.**	Year: **II**	Semester: IX
Subject: **Physics**		
Course Code: **B010907T**	Course Title: **Condensed Matter Physics-I**	

Course Outcomes (COs)

After the completion of the course, students will be able to

1. Quantize lattice vibrations and analyze phonon modes in non-primitive lattices using normal-coordinate and shell-model descriptions.
2. Analyse the optical response of solids using Kramers-Kronig relations and the concepts of plasmons, polaritons, excitons, and interband/intraband transitions.
3. Apply Hartree, Hartree-Fock, and density-functional concepts, including Thomas-Fermi, LDA, and GGA approximations, to interpret electronic structure.
4. Explain the fundamental concepts of electron transport in low-dimensional systems and describe the origin of Landau quantization in a magnetic field in quantum Hall effect, quantum spin Hall effect and topological insulators.
5. Analyse different type of Martials and its characterization technique such as XRD, SEM, TEM, FTIR etc

Credit: **4**	Specialization III
Max. Marks: 25+75	Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical-Research (in hours per week): L-T-P-R: 3-1-0-0

Unit	Topics	**No. of Lectures**
I	Phonon concept, Quantization of lattice vibrations, Phonons in perfect-crystals: General theory of lattice dynamics of nonprimitive lattice, normal coordinate description, shell model.	7
II	Basic concept of optical constants, Kramer Kroning relation, optical properties of metals, polaritons, plasmons. Optical properties of semiconductors and heterostructures, excitons. Inter and intra band transition	9

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III	Many body Techniques: The basic Hamiltonian in solid: Electronic and Ionic parts, Hartree and Hartree Fock equation, exchange energy, Density Functional Theory, Thomas Fermi approximation, Local Density Approximation (LDA), Generalized gradient approximation (GGA).	10
IV	Transport properties: Quantum Hall Effect: Integral and fractional hall effect, Landau quantization, Quantum spin hall effect, Topological Insulators.	10
V	2D materials: Graphene and Transition metal di-chalcogenides (TMDs). Thermoelectric materials. Characterization techniques: X ray diffraction (XRD), Scanning electron microscopy (SEM), Transmission electron microscopy (TEM), UV-Vis.	9

Suggested Readings

Textbooks:

I. Sholl DS, Steckel JA, "Density Functional Theory: A Practical Introduction". Wiley, 2009.
II. Fox M, "Optical Properties of Solids". Oxford University Press, 2010.
III. Kohanoff J, "Electronic Structure Calculations for Solids and Molecules". Cambridge University Press.
IV. Sharma SK, "Handbook of Material Characterization". Springer, 2018.

Reference Books

I. Locharoenrat S, "Optical Properties of Solids: An Introductory Textbook". 2010.
II. Lee JG, "Computational Materials Science: An Introduction". CRC Press, 2017. 2nd Edition.
III. Leng Y, "Materials Characterization: Introduction to Microscopic and Spectroscopic Methods". John Wiley & Sons (Asia) Pte. Ltd., 2008.

Suggested Digital Platforms/Web Links

1. Swayam – Government of India, https://swayam.gov.in/explorer?category=Physics
2. National Programme on Technology Enhanced Learning (NPTEL), https://nptel.ac.in/course.html
3. Uttar Pradesh Higher Education Digital Library, https://heecontent.upsdc.gov.in/SearchContent.aspx
4. MIT Open Learning – Massachusetts Institute of Technology, https://openlearning.mit.edu/
5. edX, https://www.edx.org/course/subject/physics

Course Prerequisites

Physics in M.Sc. 1st year

Programme: **M. Sc.**	Year: **II**	Semester: **IX**
Subject: **Physics**		
Course Code: **B010908T**	Course Title: **Condensed Matter Physics-II**	
Course Outcomes (COs)		

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After the completion of the course, students will be able to

1. Calculate dielectric and polarizability responses of ionic crystals and analyze first- and second-order Raman scattering.
2. Analyze phonons, plasmons, and polaritons and their interaction with electromagnetic radiation using Raman-scattering concepts.
3. Formulate classical and double-time quantum Green functions and analyze causality, correlation functions, and spectral density.
4. Apply static Green functions and Fourier-transform methods to lattice vibrations and electron energy states.
5. Analyze defect-induced localized, gap, and resonance modes and relate them to impurity electron energy states.

Credit: **4**	Specialization III
Max. Marks: 25+75	Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical-Research (in hours per week): L-T-P-R: 3-1-0-0

Unit	Topics	**No. of Lectures**
I	Dielectric constant of ionic crystals. Static polarizability, polarizability in variable field, Placzek's approximation, first order Raman scattering, second-order Raman scattering,	**9**
II	Elementary ideas of the study of phonons by Raman scattering Plasmons, interaction of electromagnetic waves with phonons and polaritons.	**9**
III	Excitation in imperfect crystals: Definition of classical Green functions, application to one dimensional harmonic oscillator, principle of causality. Double-time quantum Green functions, correlation functions, spectral density.	**9**
IV	Static Green function (Fourier transform), application to lattice vibrations and electron energy states.	**9**
V	Point defect in one-dimensional lattice, localized, gap and resonance modes. Elementary ideas of extension to impurity electron energy states, gap states.	**9**

Suggested Readings

Textbooks:

I. J. M. Ziman, Electrons and Phonons: The Theory of Transport Phenomena in Solids, Oxford University Press.
II. Stephen Blundell, Magnetism in Condensed Matter, Oxford University Press.
III. C. Kittel, Introduction to Solid State Physics, Wiley.
IV. M. A. Wahab, Solid State Physics: Structure and Properties of Materials, Narosa Publishing House.

Reference Books

I. N. W. Ashcroft and N. D. Mermin, Solid State Physics, Cengage Learning.
II. Robert M. White, Quantum Theory of Magnetism: Magnetic Properties of Materials, Springer.
III. H. E. Stanley, Introduction to Phase Transitions and Critical Phenomena, Oxford University Press.
IV. J. M. Ziman, Principles of the Theory of Solids, Cambridge University Press

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Suggested Digital Platforms/Web Links
1. Swayam – Government of India, https://swayam.gov.in/explorer?category=Physics 2. National Programme on Technology Enhanced Learning (NPTEL), https://nptel.ac.in/course.html 3. Uttar Pradesh Higher Education Digital Library, https://heecontent.upsdc.gov.in/SearchContent.aspx 4. MIT Open Learning – Massachusetts Institute of Technology, https://openlearning.mit.edu/ 5. edX, https://www.edx.org/course/subject/physics
Course Prerequisites
Physics in M.Sc. 1st year

Programme: **M. Sc.**	Year: II	Semester: X
Subject: **Physics**		
Course Code: **B011001T**	Course Title: **Experimental Techniques & Control Systems**	

Course Outcomes (COs)

After the completion of the course, students will be able to

1. Analyze experimental data in terms of accuracy, precision, error propagation, least-squares fitting, linear/non-linear fitting, and chi-square testing.
2. Explain and evaluate the operation of thermoelectric generators, solar cells, photodetectors, and transducers.
3. Design and analyze operational-amplifier circuits including inverting/non-inverting amplifiers, integrators, differentiators, adders, and comparators.
4. Apply the sampling theorem and compare A/D and D/A converter architectures for analog-digital signal conversion.
5. Apply Fourier-transform, lock-in, and boxcar-averaging techniques for signal recovery and execute basic 8085/microcontroller data-transfer and I/O operations.

Credit: **4**	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical-Research (in hours per week): L-T-P-R: 3-1-0-0

Unit	Topics	**No. of Lectures**
I	Data Interpretation and Analysis: precision and accuracy, error analysis, propagation of errors, least squares fitting, linear and non-linear curve fitting, chi-square test.	9
II	Thermoelectric properties of materials, Thermoelectric generator, Optoelectronic Devices; solar cells, photo-detector, transducers	9
III	Ideal operational amplifier, characteristics and applications; Inverting and non-inverting amplifier, integrator, differentiator, adder and comparator.	9
IV	Analogue v/s digital data: Statement of sampling theorem, A/D converters Flash converters, single slope, double slope and successive approximation converter), D/A converter (R-2R ladder type and weighted resistor type converter).	9
V	Fourier Transforms and lock-in detector, Box car averaging. Microprocessor 8085 and microcontroller basics, Instruction set related	9

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	to Data transfer Group. Addressing I/0 devices (Memory mapped & I/0 mapped I/O)	

Suggested Readings

Textbooks:

I. Taylor JR, "An Introduction to Error Analysis: The Study of Uncertainties in Physical Measurements". University Science Books.
II. Millman J, Taub H, "Pulse, Digital, and Switching Waveforms". McGraw-Hill.
III. Gayakwad RA, "Op-Amps and Linear Integrated Circuits". Prentice Hall of India.
IV. Gaonkar RS, "Microprocessor Architecture, Programming, and Applications with 8085". Prentice Hall of India

Reference Books

I. Chattopadhyay D, Rakshit PC, "Electronics: Fundamentals and Applications". New Age International Publishers.
II. Sze SM, Ng KK, "Physics of Semiconductor Devices". Wiley. 3rd Edition.
III. Rowe DM, "Thermoelectrics Handbook: Macro to Nano". CRC Press.

Suggested Digital Platforms/Web Links

1. Swayam – Government of India, https://swayam.gov.in/explorer?category=Physics
2. National Programme on Technology Enhanced Learning (NPTEL), https://nptel.ac.in/course.html
3. Uttar Pradesh Higher Education Digital Library, https://heecontent.upsdc.gov.in/SearchContent.aspx
4. MIT Open Learning – Massachusetts Institute of Technology, https://openlearning.mit.edu/
5. edX, https://www.edx.org/course/subject/physics

Course Prerequisites

Physics in M.Sc. 1st year

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Programme: **M. Sc.**	Year: **II**	Semester: X
Subject: **Physics**		
Course Code: **B011002T**	Course Title: **Computational Physics with Python**	

Course Outcomes (COs)

After completion of the course, the students will be able to

1. Operate a Linux-based computational environment and develop Python programs using variables, control structures, functions, classes, modules, and packages.
2. Use NumPy, SciPy, Matplotlib, and pandas to manipulate datasets and matrices and create two- and three-dimensional scientific visualizations.
3. Implement Newton-Raphson, iterative, and interpolation algorithms and evaluate their numerical convergence and accuracy.
4. Implement numerical integration, differentiation, and ordinary-differential-equation methods and compare the accuracy of alternative schemes.
5. Develop computational simulations using random numbers, Monte Carlo methods, random walks, the Ising model, and numerical solutions of wave and Schrodinger equations.

Credit: **4**	Elective I
Max. Marks: 25+75	Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical-Research (in hours per week): L-T-P-R: 3-1-0-0

Unit	Topics	**No. of Lectures**
I	Introduction to Operating systems, Linux, Python Basics: Interpreter, statements, variables, mathematical operators, loops, functions, libraries and modules, class and object, and simple applications.	9
II	Python libraries: NumPy, SciPy, matplotlib, pandas; extracting data from datafiles, managing datasets, matrix manipulation, 2D and 3D plots and graphs.	9
III	Programming for Newton-Raphson method, iterative method, Newton's forward and backward interpolation.	9
IV	Numerical integration and differentiation: Euler's methods, Trapezoidal rule, Simpson's rule, Runge-Kutta methods for ODE, Forward, Backward and Central Difference Approximations for differentiation	9
V	Programming for the motion of real pendulum, Random numbers, Monte-Carlo method, the random walk, Ising model and solution of wave equations, Schrödinger 's equation.	9

Suggested Readings

Textbooks:

I. Eric Ayars, Computational Physics with Python, California State University, 2013.
II. Rubin H. Landau, Manuel J. Páez and Cristian C. Bordeianu, Computational Physics: Problem Solving with Python, 3rd Edition, Wiley-VCH, 2015.
III. Hans Petter Langtangen, A Primer on Scientific Programming with Python, Springer, 2014.
IV. Mark Newman, Computational Physics, CreateSpace Independent Publishing Platform, 2013.

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Reference Books

I. Bill Lubanovic, Introducing Python: Modern Computing in Simple Packages, O'Reilly Media, 2015.
II. Jaan Kiusalaas, Numerical Methods in Engineering with Python 3, Cambridge University Press.
III. Christian Hill, Learning Scientific Programming with Python, Cambridge University Press.
IV. Jake VanderPlas, Python Data Science Handbook, O'Reilly Media.

Suggested Digital Platforms/Web Links

1. Swayam – Government of India, https://swayam.gov.in/explorer?category=Physics
2. National Programme on Technology Enhanced Learning (NPTEL), https://nptel.ac.in/course.html
3. Uttar Pradesh Higher Education Digital Library, https://heecontent.upsdc.gov.in/SearchContent.aspx
4. MIT Open Learning – Massachusetts Institute of Technology, https://openlearning.mit.edu/
5. edX, https://www.edx.org/course/subject/physics

Course Prerequisites

Physics in M. Sc. Physics I Year

Programme: **M. Sc.**	Year: **II**	Semester: **X**
Subject: **Physics**		
Course Code: **B011003T**	Course Title: **Quantum Information and Computing**	

Course Outcomes (COs)

Upon successful completion of the course, students will be able to:

1. Apply quantum-mechanical formalism to represent states, operators, superposition, entanglement, density operators, and generalized measurements.
2. Design and analyze qubit operations and quantum circuits using tensor products, Bloch-sphere representations, and standard quantum gates.
3. Implement and test Deutsch-Jozsa, Bernstein-Vazirani, Simon, Grover, and Shor algorithms using Qiskit and quantum simulators.
4. Construct Quantum Fourier Transform and phase-estimation circuits and apply them to period-finding and search problems using Qiskit.
5. Analyze entanglement-based protocols and evaluate quantum-noise and error-correction methods for reliable quantum information processing.

Credit: **4**	Elective II
Max. Marks: 25+75	Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical-Research (in hours per week): L-T-P-R: 3-1-0-0

Unit	Topics	**No. of Lectures**

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I	**Revisit to Quantum Mechanics:** Vector Spaces, Linear Operators, and Dirac Notation, Quantum States in Hilbert space, Schrodinger Equation, Heisenberg Uncertainty Principle, Postulates in Quantum Mechanics, Superposition and Entanglement, Pauli Matrices and other Operators, Density Operators and Generalized Measurements	9
II	**Qubit Operations and Quantum Circuits:** No-Cloning Theorem, Tensor Products, Bloch Sphere Representation, Qubit Representation and Operations, Hadamard, CNOT, and other Gates, Quantum Circuit Design and Implementation	9
III	**Quantum Programming and Algorithms:** Introductory Programming with Qiskit, Quantum Simulators and Platforms, Implementing and Visualizing Quantum Algorithms, Deutsch-Jozsa, Bernstein-Vazirani, and Simon's algorithms, Grover's Search Algorithm, Shor's Factoring Algorithm,	9
IV	**Quantum Fourier Transform:** Quantum Fourier Transform and Quantum Phase Estimation, Quantum Fourier Transform, QFT implementation in Qiskit, Quantum Phase Implementation, Quantum Phase Estimation in Qiskit, Shor's Period Finding Algorithm, Grover's Search Algorithm	9
V	**Quantum Entanglement and Applications:** Bell States and Entanglement, Quantum Teleportation, Superdense Coding, Quantum Key Distribution, Quantum Information Theory, Quantum Error-Correcting Codes, Quantum Error Correction Protocols, Quantum Noise and Error Analysis	9

Suggested Readings

Textbooks:

I. Nielsen MA, Chuang IL, "Quantum Computation and Quantum Information". Cambridge University Press, 2010. 10th Anniversary Edition.

II. Byrnes NC, "Quantum Computing for Computer Scientists". Springer, 2009

Reference Books

I. Schumacher B, Nielsen MA, "Quantum Information Theory". Cambridge University Press.

Suggested Digital Platforms/Web Links

1. Swayam – Government of India, https://swayam.gov.in/explorer?category=Physics
2. National Programme on Technology Enhanced Learning (NPTEL), https://nptel.ac.in/course.html
3. Uttar Pradesh Higher Education Digital Library, https://heecontent.upsdc.gov.in/SearchContent.aspx
4. MIT Open Learning – Massachusetts Institute of Technology, https://openlearning.mit.edu/
5. edX, https://www.edx.org/course/subject/physics

Course Prerequisites

Physics in M. Sc. I Year

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Programme: **M. Sc.**	Year: II	Semester: X
Subject: **Physics**		
Course Code: **B011005T**	Course Title: **Microprocessor and Computational Electronics**	

Course Outcomes (COs)

After the completion of the course, students will be able to

1. Analyze the 8085 microprocessor architecture, programmable registers, control signals, instruction cycles, and machine cycles.
2. Develop and execute 8085 programs using appropriate addressing modes and instruction groups and analyze electronic circuits using PSpice.
3. Explain the Hohenberg-Kohn theorems and Kohn-Sham equations and apply LDA, GGA, pseudopotential, and plane-wave concepts in density-functional calculations.
4. Perform band-structure and density-of-states calculations and analyze changes in electronic properties produced by doping, defects, and dimensionality.
5. Develop and execute 8085-based computational routines and interpret their outputs for specified numerical and electronics tasks.

Credit: **4**	Specialization I
Max. Marks: 25+75	Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical-Research (in hours per week): L-T-P-R: 3-1-0-0

Unit	Topics	**No. of Lectures**
I	Microprocessor 8085, Hardware description, Programmable Registers, Generation of control signal, Instruction cycle, machine cycle and T-states.	9
II	Instruction set and addressing mode, Data transfer group, Arithmetic group, Branch group, Logic group, Stack operation, input/output and machine control group.	9
III	Basics of electronic properties of materials, Introduction to Density Functional Theory (DFT): Many-body problem and need for approximations, Hohenberg–Kohn theorems and Kohn–Sham equations, Exchange-correlation approximations (LDA, GGA), Pseudopotentials and plane-wave basis sets	9
IV	DFT calculation of electronic properties: Workflow for band structure and DOS calculations, Band gap determination and corrections, Engineering Electronic Properties via Tuning Techniques: Doping, Defects, Dimensionality.	9
V	8085 Assembly Language Programming and Computational Applications Using DFT	9

Suggested Readings

Textbooks:

I. Gaonkar RS, "Microprocessor Architecture, Programming, and Applications with 8085". Prentice Hall of India.
II. Hall DV, "Microprocessor and Interfacing". McGraw-Hill.
III. Martin RM, "Electronic Structure: Basic Theory and Practical Methods". Cambridge University Press.

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Reference Books

I. Kittel C, "Introduction to Solid State Physics". John Wiley & Sons.
II. Ashcroft NW, Mermin ND, "Solid State Physics". Holt, Rinehart and Winston.
III. Sholl DS, Steckel JA, "Density Functional Theory: A Practical Introduction". Wiley.

Suggested Digital Platforms/Web Links

1. Swayam – Government of India, https://swayam.gov.in/explorer?category=Physics
2. National Programme on Technology Enhanced Learning (NPTEL), https://nptel.ac.in/course.html
3. Swayam–Government of India, https://onlinecourses.nptel.ac.in/noc25_ee62/preview
4. National Programme on Technology Enhanced Learning (NPTEL), https://onlinecourses.nptel.ac.in/noc25_ph06/preview
5. Uttar Pradesh Higher Education Digital Library, https://heecontent.upsdc.gov.in/SearchContent.aspx

Course Prerequisites

Physics in M.Sc. 1st year

Programme: **M. Sc.**	Year: II	Semester: X
Subject: **Physics**		
Course Code: **B011006T**	Course Title: **Physics of Semiconductor Devices**	

Course Outcomes (COs)

After the completion of the course, students will be able to

1. Calculate carrier concentrations, recombination, current density, and continuity relations in intrinsic and extrinsic semiconductors.
2. Analyze PN-junction diode current-voltage behavior, junction and diffusion capacitance, and temperature dependence.
3. Analyze varactor and tunnel diodes and evaluate their use in parametric conversion, amplification, and oscillation.
4. Compare Gunn, IMPATT, and Schottky devices and analyze their operating modes, negative conductance, power, and frequency performance.
5. Analyze microwave bipolar-junction-transistor geometry, cutoff frequency, and performance.

Credit: **4**	Specialization I
Max. Marks: 25+75	Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical-Research (in hours per week): L-T-P-R: 3-1-0-0

Unit	Topics	No. of Lectures
I	Semiconductor Physics: Carrier concentration in intrinsic and extrinsic semiconductors, recombination process, current density and continuity equations.	9
II	P-n junction diode: Junction and diffusion capacitance, Ideal diode equation, temperature dependence of voltage and current.	9
III	Varactor diode and parametric conversion and amplification, Tunnel diode, V-I characteristics, tunnel diode as an amplifier and as an oscillator.	9

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IV	Gunn diode, modes of operation, power and frequency performance. Impact Diode: Static and dynamic characteristic, small signal analysis and negative conductance, power and frequency performance, Schottky effect and Schottky diode.	9
V	Microwave transistor, cut off frequency, device geometry and performance.	9

Suggested Readings

Textbooks:

I. Singh J, "Semiconductor Devices", Wiley, 2004
II. Kumar J, Tiwari AK, Singh D, "Electronics devices and Circuits", Narosa, 2017
III. Sze SM, Ng KK, "Physics of Semiconductor Devices". Wiley-Interscience, 2007. 3rd Edition.
IV. Neamen DA, "An Introduction to Semiconductor Devices". McGraw-Hill, 2006.
V. Yu PY, Cardona M, "Fundamentals of Semiconductors: Physics and Materials Properties". Springer, Heidelberg, 2010.

Reference Books

I. Singh J, "Semiconductor Devices". John Wiley & Sons, New York, 2001.
II. Shur M, "Physics of Semiconductor Devices". Pearson India Education Services Pvt. Ltd., Noida, 2019.
III. Paul PJ, "Electronic Devices and Circuits". New Age International (P) Ltd., New Delhi, 2017

Suggested Digital Platforms/Web Links

1. Swayam – Government of India, https://swayam.gov.in/explorer?category=Physics
2. National Programme on Technology Enhanced Learning (NPTEL), https://nptel.ac.in/courses/108108122
3. Uttar Pradesh Higher Education Digital Library, https://heecontent.upsdc.gov.in/SearchContent.aspx
4. MIT Open Learning – Massachusetts Institute of Technology, https://openlearning.mit.edu/
5. edX, https://www.edx.org/course/subject/physics

Course Prerequisites

Physics in M.Sc. 1st year

Programme: **M. Sc.**	Year: **II**	Semester: X
Subject: **Physics**		
Course Code: **B011007T**	Course Title: **Advanced Atomic Spectroscopy**	

Course Outcomes (COs)

After the completion of the course, students will be able to

1. Analyze the Lamb shift in the hydrogen spectrum and explain its spectroscopic significance.
2. Interpret complex atomic spectra, including multiplicity alternation and inversion of states, using representative atomic systems.

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3. Derive spectral terms using Breit's scheme and analyze the properties of Rydberg atoms and Rydberg states.
4. Compare the principles and analytical capabilities of ICP-OES, ICP-MS, PES, AES, and XRF spectroscopic techniques.
5. Evaluate the limitations and applications of optical, electron, scanning-probe, and fluorescence microscopy techniques.

Credit: 4	Specialization II
Max. Marks: 25+75	Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical-Research (in hours per week): L-T-P-R: 3-1-0-0

Unit	Topics	No. of Lectures
I	Lamb – shift in hydrogen spectrum.	9
II	Complex Spectra and their interpretation, nitrogen, oxygen and manganese as examples, Alternation of multiplicities, Inversion of states.	9
III	Breit's Scheme for spectral term derivation, Rydberg atoms and Rydberg states.	9
IV	Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES), Inductively Coupled Plasma Mass Spectroscopy (ECP-MS) Photo electron spectroscopy (PES), Auger Electron Spectroscopy (AES), X-Ray Fluorescence Spectroscopy (XRF).	9
V	Limitations of Optical Microscope and Electron Microscope, Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Atomic Force Microscopy (AFM), Scanning Tunneling Electron Microscopy (STEM), Fluorescence Microscopy.	9

Suggested Readings

Textbooks:

I. Herzberg G, "Atomic Spectra and Atomic Structure". Dover Publications, New York.
II. Aruldhas G, "Molecular Structure and Spectroscopy". Prentice Hall of India, New Delhi.
III. Colthup ND, Daly LH, Wiberley SE, "Introduction to Infrared and Raman Spectroscopy". Academic Press, New York.

Reference Books

I. Herzberg G, "Molecular Spectra and Molecular Structure, Volume I: Spectra of Diatomic Molecules".
II. Lakowicz JR, "Principles of Fluorescence Spectroscopy".

Suggested Digital Platforms/Web Links

1. Swayam – Government of India, https://swayam.gov.in/explorer?category=Physics
2. National Programme on Technology Enhanced Learning (NPTEL), https://nptel.ac.in/courses/108108122
3. Uttar Pradesh Higher Education Digital Library, https://heecontent.upsdc.gov.in/SearchContent.aspx
4. MIT Open Learning – Massachusetts Institute of Technology, https://openlearning.mit.edu/
5. edX, https://www.edx.org/course/subject/physics

Course Prerequisites

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		45-09-26		11.9.26

Physics as a major subject in B. Sc.

Programme: **M. Sc.**	Year: **II**	Semester: **X**
Subject: **Physics**		
Course Code: **B011008T**	Course Title: **IR & Raman Spectra of Polyatomic Molecules**	

Course Outcomes (COs)

After the completion of the course, students will be able to

1. Classify molecules into point groups using symmetry elements and symmetry operations.
2. Apply rotational-vibrational selection rules to linear molecules and analyze parallel and perpendicular spectral bands.
3. Construct normal and symmetry coordinates and determine the symmetries of normal modes in representative polyatomic molecules.
4. Analyze pure rotational Raman and far-infrared spectra, intensity alternation, IR/Raman activity, and functional-group signatures.
5. Analyze rotation-vibration interactions, Coriolis effects, energy levels, and symmetry properties in the IR and Raman spectra of linear polyatomic molecules.

Credit: **4**	Specialization II
Max. Marks: 25+75	Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical-Research (in hours per week): L-T-P-R: 3-1-0-0

Unit	Topics	**No. of Lectures**
I	Symmetry Elements and Symmetry Operations, Point Groups, Classification of Molecules into Point Groups.	9
II	Rotational vibration spectra of Linear molecule, Selection Rules and Transition of Rigid Rotator, Parallel and Perpendicular bands in linear molecules.	9
III	Vibrational Motion, Normal co-ordinates and Normal modes of vibration, Accidental degeneracy, Vibrational Energy, Symmetry Co-ordinates, Symmetries of Normal modes of Vibration of N_2O and CO_2 molecules.	9
IV	Pure Rotational Structure in the Raman and Far Infrared Spectra of Linear molecules, Alternation of Intensity. Active and Inactive IR and Raman Fundamentals, Functional Group Analysis.	9
V	Interaction of Rotation and Vibration, Rotation Vibration Spectra of Linear Polyatomic Molecule, Energy levels and Symmetry Properties, Coriolis Interaction, IR and Raman Spectra of Linear Polyatomic Molecule.	9

Suggested Readings

Textbooks:

i. G. Herzberg, Infrared and Raman Spectra of Polyatomic Molecules, Van Nostrand Reinhold.

ii. C. N. Banwell and E. M. McCash, Fundamentals of Molecular Spectroscopy, 4th Edition, McGraw-Hill.C.N. Banwell and E.M. McCash, Fundamentals of Molecular Spectroscopy.

Reference Books

Dr. Alok K. Verma (Internal Member) | Prof. P. K. Yadawa (Internal Member) | Prof. Devraj Singh (Internal Member) | Dr. Anil K Yadav (External Expert) | Prof. Giridhar Mishra (Convener)

i. E. B. Wilson, J. C. Decius and P. C. Cross, Molecular Vibrations: The Theory of Infrared and Raman Vibrational Spectra, Dover Publications.
ii. Chandra, S., Molecular Spectroscopy, Narosa Publishing House, New Delhi.
iii. P. F. Bernath, Spectra of Atoms and Molecules, Oxford University.

Suggested Digital Platforms/Web Links

1. Swayam – Government of India, https://swayam.gov.in/explorer?category=Physics
2. National Programme on Technology Enhanced Learning (NPTEL), https://nptel.ac.in/courses/108108122
3. Uttar Pradesh Higher Education Digital Library, https://heecontent.upsdc.gov.in/SearchContent.aspx
4. MIT Open Learning – Massachusetts Institute of Technology, https://openlearning.mit.edu/

edX, https://www.edx.org/course/subject/physics

Course Prerequisites

Physics as a major subject in B. Sc.

Programme: **M. Sc.**	Year: **II**	Semester: **X**
Subject: **Physics**		
Course Code: **B011009T**	Course Title: **Condensed Matter Physics- III**	

Course Outcomes (COs)

After the completion of the course, students will be able to

1. Apply the linearized Boltzmann equation and relaxation-time approximation to analyze transport coefficients and entropy production in solids.
2. Calculate electrical and thermal conductivities and Peltier and Seebeck coefficients, and evaluate electronic and lattice contributions to transport.
3. Compare magnetic models using exchange interactions, the Ising model, Bragg-Williams approximation, and two-sublattice descriptions of ferro-, antiferro-, and ferrimagnetism.
4. Apply second-quantization and Holstein-Primakoff methods to derive magnon properties, heat capacity, saturation magnetization, and sublattice magnetization.
5. Analyze magnetic phase transitions using Landau's theory, order parameters, fluctuations, critical exponents, and scaling concepts.

Credit: **4**	Specializiation III
Max. Marks: 25+75	Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical-Research (in hours per week): L-T-P-R: 3-1-0-0

Unit	Topics	**No. of Lectures**
I	Transport Theory: Phenomenological coefficient L_{ij} and their physical inter reaction. General Boltzmann equation and its linearization Entropy production. Relaxation time solution of Boltzmann equation.	9
II	Electronic contributions of thermal and electrical conductivities and to Peltier, Seeback coefficient for metals and electronic semiconductors. Relationship between electrical and ideas about lattice contribution to thermal conductivity.	9
III	Magnetism: Classical and Semi Classical Theories: Failure to explain large internal fields. Exchange interaction. Ising Model. Bragg William	9

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	Approximation. Explanation of large external fields. Non-existence of ferromagnetism in two-dimensional Ising Model. Two sub-lattice Model and classical theories of anti-ferromagnetism and ferrimagnetism, Ferrites and garnets.	
IV	Second Quantized Theory: Ferromagnetic Heisenberg Hamiltonian, Holstein-Primakoff transformations and their application to Heisenberg Hamiltonian for small fractional spin reversal. Ferromagnetic magnons, Magnon heat capacity and saturation magnetization at small temperatures. Antiferromagnetic Hamiltonian and its reduction using Holstein Primakoff transformation, Antiferromagnetic magnons. Zeropoint sub-lattice magnetization.	9
V	The Magnetic Phase Transition: Order parameter, Landau's theory of second order phase Transitions. Fluctuations of the order parameter. Elementary qualitative ideas about critical exponents and scaling.	9

Suggested Readings

Textbooks:

I. J. M. Ziman, *Electrons and Phonons: The Theory of Transport Phenomena in Solids*, Oxford University Press.
II. Stephen Blundell, *Magnetism in Condensed Matter*, Oxford University Press.
III. C. Kittel, *Introduction to Solid State Physics*, Wiley.
IV. M. A. Wahab, *Solid State Physics: Structure and Properties of Materials*, Narosa Publishing House.

Reference Books

I. N. W. Ashcroft and N. D. Mermin, Solid State Physics, Cengage Learning.
II. Robert M. White, Quantum Theory of Magnetism: Magnetic Properties of Materials, Springer.
III. H. E. Stanley, Introduction to Phase Transitions and Critical Phenomena, Oxford University Press.
IV. J. M. Ziman, Principles of the Theory of Solids, Cambridge University Press.

Suggested Digital Platforms/Web Links

1. Swayam – Government of India, https://swayam.gov.in/explorer?category=Physics
2. National Programme on Technology Enhanced Learning (NPTEL), https://nptel.ac.in/courses/108108122
3. Uttar Pradesh Higher Education Digital Library, https://heecontent.upsdc.gov.in/SearchContent.aspx
4. MIT Open Learning – Massachusetts Institute of Technology, https://openlearning.mit.edu/

edX, https://www.edx.org/course/subject/physics

Course Prerequisites

Physics as a major subject in B. Sc.

Programme: **M. Sc.**	Year: **II**	Semester: **X**

Dr. Alok K. Verma (Internal Member) | Prof. P. K. Yadawa (Internal Member) | Prof. Devraj Singh (Internal Member) 11.09.26 | Dr. Anil K Yadav (External Expert) | Prof. Giridhar Mishra (Convener) 11.9.26

Subject: **Physics**	
Course Code: **B011010T**	Course Title: **Condensed Matter Physics- IV**

Course Outcomes (COs)

After the completion of the course, students will be able to

1. Formulate many-electron Hamiltonians in second-quantized form and analyze Coulomb and screened Coulomb interactions.
2. Apply linear-response theory and the Lindhard formalism to calculate dielectric response and screening in an electron gas.
3. Analyze electron-phonon interactions using deformation-potential and Born-approximation concepts and interpret polaron formation.
4. Derive phonon-mediated electron-electron attraction and Cooper pairing and diagonalize the reduced superconducting Hamiltonian using the Bogoliubov-Valatin transformation.
5. Analyze superconducting ground and excited states, the temperature dependence of the energy gap, transition temperature, Meissner effect, and flux quantization.

Credit: **4**	Specializiation III
Max. Marks: 25+75	Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical-Research (in hours per week): L-T-P-R: 3-1-0-0

Unit	Topics	**No. of Lectures**
I	Many Electron Systems: Second quantization for Fermions, field operators, electron density operator, Hamiltonian for two particle interactions in second quantized form: Coulombian interaction and screened Coulombian interaction.	9
II	Linear Response Theory: Dielectric response analysis, dielectric constant for electron gas in self-consistent approximation, Lindhard formula, dielectric constant. Dielectric screening of a point charge impurity.	9
III	Electron-Phonon Interaction: Long wavelength limit, deformation potential interaction, Born approximation, deformation potential perturbation Hamiltonian, Normal processes, polaron. Number of phonons accompanying electron.	9
IV	Electron-electron interaction via phonons, Attractive interaction, Cooper pairs, Reduced Hamiltonian for superconducting state. Bogoliubo-Valatin transformation, Diagonal and non-diagonal terms.	9
V	Superconducting ground state energy, nature of ground state, excited states, Temperature dependence of energy gap, Transition temperature, Simple treatment of Meissner effect and flux quantization.	9

Suggested Readings

Textbooks:

I. Quantum Theory of Solids, C. Kittel, 2nd Ed., John Wiley and Sons, USA, 1987.
II. Quantum Theory of Solid State, Joseph Callaway, Academic Press (1991).

Reference Books

I. Principles of the Theory of Solids", J.M. Ziman

Suggested Digital Platforms/Web Links

1. Swayam – Government of India, https://swayam.gov.in/explorer?category=Physics

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2. National Programme on Technology Enhanced Learning (NPTEL), https://nptel.ac.in/courses/108108122
3. Uttar Pradesh Higher Education Digital Library, https://heecontent.upsdc.gov.in/SearchContent.aspx
4. MIT Open Learning – Massachusetts Institute of Technology, https://openlearning.mit.edu/

edX, https://www.edx.org/course/subject/physics

Course Prerequisites

Physics as a major subject in B. Sc.

Programme: **M. Sc.**	Year: II	Semester: IX/X
Subject: **Physics**		
Course Code: **B010909P/B011011P**	Course Title: **Electronics Lab**	

Course Outcomes (COs)

After the completion of the course, students will be able to

1. Characterize operational amplifiers and analyze inverting, non-inverting, differential, and wide-band amplifier responses from measured parameters.
2. Design and test integrator, differentiator, voltage-follower, active-filter, and analog-computation circuits.
3. Implement A/D and D/A conversion and 8085/IC-based experiments and evaluate their conversion and computational performance.
4. Analyze microwave components through klystron-mode, directional-coupler, Magic-T, microstrip-line, and Gunn-diode measurements.
5. Measure VSWR and dielectric properties and evaluate microwave detector and amplifier characteristics from experimental data.

Credit: **4**	Specialization I
Max. Marks: 25+75	Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical-Research (in hours per week): L-T-P-R: 0-0-8-0

List of Experiments

1. Characterization of Op-Amp: bias current, offset current, offset voltage, inverting amplifier, non-inverting amplifier, CMRR, Slew rate, etc.
2. Application of Op-Amp: Integrator, Differentiator, Voltage follower, Differential Amplifier, etc.
3. Active Filters
4. Analog computation
5. A/D and D/A converter
6. Microprocessor 8085
7. IC Familiarization
8. Microstrip Line
9. GUNN Diode and Magic T
10. Mode analysis of Klystron and Directional Coupler

Suggested Readings

Textbooks:

I. Gayakwad RA, "Op-Amps and Linear Integrated Circuits". Prentice Hall of India
II. Liao SY, "Microwave Devices and Circuits". Pearson Education, 3rd Edition.

Dr. Alok K. Verma (Internal Member)	Prof. P. K. Yadawa (Internal Member)	Prof. Devraj Singh (Internal Member)	Dr. Anil K Yadav (External Expert)	Prof. Giridhar Mishra (Convener)

III. Millman J, Halkias CC, Parikh CD, "Integrated Electronics: Analog and Digital Circuits and Systems". McGraw Hill Education.

Reference Books

I. Chattopadhyay D, Rakshit PC, "Electronics: Fundamentals and Applications". New Age International Publishers.
II. Gaonkar RS, "Microprocessor Architecture, Programming, and Applications with 8085". Prentice Hall of India.
III. Collins RE, "Foundations for Microwave Engineering". John Wiley & Sons, 2nd Edition.

Course Prerequisites
Physics in M. Sc. I Year.

Programme: **M. Sc.**	Year: II	Semester: IX
Subject: **Physics**		
Course Code: **B010910P/B011012P**	Course Title: **Laser and Spectroscopy Lab**	

Course Outcomes (COs)

1. Perform the Zeeman-effect experiment and calculate atomic level splitting and related angular-momentum parameters.
2. Acquire and analyze laser-induced-fluorescence, laser-excited, and chlorophyll-fluorescence spectra and interpret their spectral features.
3. Measure spectral-line intensities and identify unknown elements from recorded emission spectra.
4. Characterize LED and laser-diode properties and evaluate their source performance.
5. Use a fibre-optic UV-Vis spectrometer to measure and analyze absorbance, reflectance, transmittance, and fluorescence of different samples.

Credit: **4**	Specialization II
Max. Marks: 25+75	Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical-Research (in hours per week): L-T-P-R: 0-0-8-0

List of Experiments

1. Study of Zeeman Effect
2. Study of L.I.F spectra
3. Study of Laser excited spectra
4. Laser induced fluorescence study of chlorophyll.
5. Intensity measurement of spectral lines.
6. Detection of unknown elements by recording emission spectra.
7. LED and Laser Diode Characteristics
8. Fiber Optic UV-Vis Spectrometer for Absorbance of powder, liquid & thin film Samples.
9. Fiber Optic UV-Vis Spectrometer for Reflectance of powder, liquid & thin film Samples.
10. Fiber Optic UV-Vis Spectrometer for Transmission of powder, liquid & thin film Samples.

Fiber Optic UV-Vis Spectrometer for Basic Fluorescence of Liquid Samples

Dr. Alok K. Verma (Internal Member) | Prof. P. K. Yadawa (Internal Member) | Prof. Devraj Singh (Internal Member) 11.09.26 | Dr. Anil K Yadav (External Expert) | Prof. Giridhar Mishra (Convener) 11.9.26

Suggested Readings
Textbooks: I. Demtröder W, "Laser Spectroscopy: Basic Concepts and Instrumentation". Springer. II. Ghatak A, Thyagarajan K, "Lasers: Theory and Applications". Springer. III. Lakowicz JR, "Principles of Fluorescence Spectroscopy". Springer. **Reference Books** I. Herzberg G, "Atomic Spectra and Atomic Structure". Dover Publications, New York. II. Colthup ND, Daly LH, Wiberley SE, "Introduction to Infrared and Raman Spectroscopy". Academic Press, New York. III. Aruldhas G, "Molecular Structure and Spectroscopy". Prentice Hall of India, New Delhi.
Course Prerequisites
Physics in M. Sc. I Year.

Programme: **M. Sc.**	Year: II	Semester: IX/X
Subject: **Physics**		
Course Code: **B010911P/B011013P**	Course Title: **Condensed Matter Physics Lab**	

Course Outcomes (COs)

After the completion of the course, students will be able to

1. Determine crystal structures and lattice parameters from X-ray diffraction patterns and analyze the corresponding diffraction data.
2. Measure Hall coefficient, resistivity, and semiconductor energy gap and analyze their temperature dependence using Hall, four-probe, and optical methods.
3. Characterize magnetic properties using ESR, hysteresis, and Curie-temperature measurements and determine relevant material parameters.
4. Analyze monoatomic and diatomic lattice dynamics and identify acoustic modes, optical modes, and energy gaps.
5. Evaluate tunnelling and thermoluminescence/F-centre behaviour and relate the observations to condensed-matter models.

Credit: **4**	Specialization III
Max. Marks: 25+75	Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical-Research (in hours per week): L-T-P-R: 0-0-8-0

List of Experiments

1. X-Ray Diffraction
2. Hall Effect
3. Measurement of Energy Gap in Semiconductor Four Probe Method.
4. Hysteresis Characterization of Different Samples.
5. Lattice Dynamics of monoatomic and diatomic lattices.
6. Measurement of Curie Temperature.
7. ESR Experiment.
8. Measurement of tunnelling current through a metal-insulator junction.
9. Thermoluminescence of F-centres.
10. Measurement of energy gap, refractive index, and absorption coefficient of semiconductor by using optical method.

Suggested Readings

Dr. Alok K. Verma (Internal Member)	Prof. P. K. Yadawa (Internal Member)	Prof. Devraj Singh (Internal Member)	Dr. Anil K Yadav (External Expert)	Prof. Giridhar Mishra (Convener)
		52 11-09-26		11.9.26

Textbooks:

I. Kittel C, "Introduction to Solid State Physics". John Wiley & Sons, 8th Edition.
II. Dekker AJ, "Solid State Physics". McMillan India.
III. Sze SM, Ng KK, "Physics of Semiconductor Devices". Wiley-Interscience, 3rd Edition.

Reference Books

I. Ashcroft NW, Mermin ND, "Solid State Physics". Holt, Rinehart and Winston.
II. Yu PY, Cardona M, "Fundamentals of Semiconductors: Physics and Materials Properties". Springer.
III. Cullity BD, Stock SR, "Elements of X-Ray Diffraction". Pearson.
IV. Weil JA, Bolton JR, "Electron Paramagnetic Resonance: Elementary Theory and Practical Applications". Wiley

Course Prerequisites

Physics in M. Sc. I Year.

Programme: **M. Sc.**	Year: II	Semester: X
Subject: **Physics**		
Course Code: **B011014R**	Course Title: **Dissertation Phase 4**	

Course Outcomes (COs)

After the completion of the course, students will be able to

1. Analyze the collected research data using appropriate methods and extract significant and defensible results.
2. Evaluate the results critically in the context of relevant literature, assumptions, uncertainties, and limitations.
3. Create a structured dissertation/report that presents the methodology, results, discussion, conclusions, and references coherently.
4. Present and defend the research findings effectively in an oral presentation and respond to questions using evidence from the project.

Credit: **4**	Core Compulsory
Max. Marks: 100	Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical-Research (in hours per week): L-T-P-R: 0-0-0-8

	Topics	
	Final Report Submission and Presentation	

Suggested Readings

As per the field of the project.

Suggested Digital Platforms/Web Links

1. Google Scholar (https://scholar.google.com/)
2. ScienceDirect (https://www.sciencedirect.com/)
3. Scopus (https://www.elsevier.com/en-in/solutions/scopus)
4. Web of Science (http://webofscience.com/wos/woscc/basic-search)

Course Prerequisites

Physics in M. Sc. I Year.

Programme: **M. Sc.**	Year: II	Semester: X
Subject: **Physics**		

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Course Code: **B011015S**	Course Title: **Quantum Transport**

Course Outcomes (COs)

After successful completion of this course, students will be able to:

1. Analyze quantum-confinement effects, density of states, surface states, band bending, contacts, and semiconductor heterostructures in low-dimensional transport.
2. Analyze two-dimensional transport phenomena including flux quantization, Shubnikov-de Haas oscillations, quantum Hall effect, weak localization, universal conductance fluctuations, Aharonov-Bohm effect, and spin-orbit/topological effects.
3. Evaluate one- and zero-dimensional devices including quantum point contacts, nanowires, atomic contacts, quantum dots, Coulomb blockade, shell filling, and spin-qubits.
4. Analyze mesoscopic superconductivity through Josephson junctions, AC/DC Josephson effects, and SQUID operation.
5. Explain the principles of quantum electrical metrology and quantum electrical amplifiers and evaluate their applications.

Credit: 3	Elective III
Max. Marks: As per SWAYAM	Min. Passing Marks: As per SWAYAM

Total No. of Lectures-Tutorials-Practical-Research (in hours per week): **As per SWAYAM**

Weeks	Topics
1	Introduction, Quantum confinement effects in transport, Density of states
2	Surface states & band bending, Metal semiconductor contacts Semiconductor heterostructures
3	2D electron systems, Quantum confinement by electrostatic shaping, Overview of device fabrication techniques.
4	2D systems: Flux quantization, Shubnikov-de Haas oscillations & Quantum Hall effect
5	2D systems: Weak-localization, Universal conductance fluctuations, Aharonov-Bohm effect
6	2D layered systems, Spin-Orbit coupling, topological insulators
7	1D systems: Quantum point contacts, Nanowires
8	1D systems: atomic point contacts, charge sensing techniques
9	0D systems: Gated Quantum dots, artificial atoms, Coulomb blockade, Single electron charging
10	0D systems: Shell filling, single electron states, Coupled quantum dots, spin-qubits
11	Mesoscopic superconductivity: Josephson junctions, AC and DC Josephson effects, SQUID
12	Quantum electrical Metrology, quantum electrical amplifiers

Suggested Readings

Textbooks:

I. Datta S, "Electronic Transport in Mesoscopic Systems". Cambridge University Press, 1995.
II. Nazarov YV, Blanter YM, "Quantum Transport: Introduction to Nanoscience". Cambridge University Press, 2009.

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		54 09-24	21/9/24	11.9.24

III. Imry Y, "Introduction to Mesoscopic Physics". Oxford University Press, 2002. 2nd Edition.

Reference Books

I. Beenakker CWJ, van Houten H, "Quantum Transport in Semiconductor Nanostructures". Solid State Physics, Volume 44, Academic Press, 1991.
II. van der Wiel WG, De Franceschi S, Elzerman JM, Fujisawa T, Tarucha S, Kouwenhoven LP, "Electron Transport through Double Quantum Dots". Reviews of Modern Physics, 2002.
III. Büttiker M, "Quantum Coherence in Mesoscopic Systems". IBM Journal of Research and Development, 1988.

Web Link on SWAYAM
https://onlinecourses.nptel.ac.in/noc21_ph08/preview
Course Prerequisites
Physics as a major subject in B. Sc.

Programme: **M. Sc.**	Year: II	Semester: X
Subject: **Physics**		
Course Code: **B011016S**	Course Title: **Topology and Condensed Matter Physics**	

Course Outcomes (COs)

After successful completion of this course, students will be able to:

1. Explain the role of symmetry and topology in condensed matter and classify topological phases using the ten-fold way and the periodic table of topological insulators.
2. Calculate and interpret Berry curvature and Chern numbers and analyze the quantum Hall effect and Hofstadter model as topological systems.
3. Analyze the SSH and Kitaev models, Majorana modes, and bulk-boundary correspondence.
4. Analyze two-dimensional topological models including graphene, Haldane, BHZ, and Kane-Mele models and interpret edge modes, band inversion, and the quantum spin Hall effect.
5. Compare three-dimensional topological insulators and Weyl semimetals and evaluate their experimental signatures and progress.

Credit: 2	Elective IV
Max. Marks: 25+75	Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical-Research (in hours per week): **As per SWAYAM**

Weeks	Topics
1	Introduction to Topology, Relevance of topology in Condensed Matter Physics, symmetry and topology
2	Ten-fold way, periodic table of topological insulators, overview of topological materials.
3	Topological invariants, Berry curvature, Chern number, Quantum Hall effect, Hofstadter model
4	SSH Model, Kitaev model, Majorana fermions, Bulk boundary correspondence

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5	Two dimensional topological materials, Graphene, Haldane model, Half-BHZ Model, Kane Mele model, edge modes
6	Quantum spin Hall effect, experimental discovery of strained semiconductors, band inversion
7	Three dimensional topological insulators, Weyl semi metals
8	Experimental discovery and progress of Topological insulators

Suggested Readings

Textbooks:

I. Bernevig BA, Hughes TL, "Topological Insulators and Topological Superconductors". Princeton University Press, 2013.
II. Asbóth JK, Oroszlány L, Pályi A, "A Short Course on Topological Insulators: Band Structure and Edge States in One and Two Dimensions". Springer, 2016.
III. Shen S-Q, "Topological Insulators: Dirac Equation in Condensed Matters". Springer, 2012.

Reference Books

I. Hasan MZ, Kane CL, "Colloquium: Topological Insulators". Reviews of Modern Physics, 2010.
II. Qi X-L, Zhang S-C, "Topological Insulators and Superconductors". Reviews of Modern Physics, 2011.
III. Chiu C-K, Teo JCY, Schnyder AP, Ryu S, "Classification of Topological Quantum Matter with Symmetries". Reviews of Modern Physics, 2016

Web Link on SWAYAM

https://onlinecourses.nptel.ac.in/noc24_ph18/preview

Course Prerequisites

Physics as a major subject in B. Sc.

Dr. Alok K. Verma (Internal Member)	Prof. P. K. Yadawa (Internal Member)	Prof. Devraj Singh (Internal Member)	Dr. Anil K Yadav (External Expert)	Prof. Giridhar Mishra (Convener)