Post Graduate Programme

In

Department of Physics

Credit Based Curriculum

P.G. Department of Physics
National Institute of Technology Srinagar
Hazratbal-Srinagar (190006), Jammu and Kashmir (India)

September, 2020

P.G Department of Physics
NIT Srinagar (J & K)

September 21, 2020

Greetings Dear New Students

On behalf of my dear colleagues and on my personnel behalf as the Programme Coordinator, we want to be among the first to congratulate and welcome you. **Earning a place in NIT Srinagar is an achievement and we are delighted that you will continue your intellectual journey in this prestigious institution, which is blessed with a diverse community.** You will discover that one our defining characters is our commitment to freedom of enquiry and expression. Mutual respect and civility are the vital to all of us and you will find you will be engaged in debates, discussions, deliberations and at times this may cause discomfort.

This e-brochure is now updated and contains practical information of the masters' programme in systematic manner and has been updated according to the guidelines in **New Education Policy 2020**. The programme with its core-specialization structure offers a wide variety of possibilities, enabling you to pursue your particular ambitions and interests in this fascinating area of science. Courses at different levels of specialization will enable you to deepen your physics knowledge and find out how it is applied in modern research and development. There are various electives and optional subjects which are interdisciplinary and has immense applications in all spheres of life. It is at par from the existing syllabi of other universities and other NIT's/IITs.

The department has **state** of the **art laboratory** facilities with modern sophisticated **equipment.** The laboratories once completely established in all respects shall be made open to the interested students of the country, where they can carry their summer/winter internships also. We are convinced that we have created a rewarding and challenging post graduate programme in Physics for the first time in the History of NIT Srinagar that keeps its promise which will prepare you for the future.

The academic loss due to pandemic which is our common sorrow and common pain can be compensated with extra classes. We are less in number nevertheless academically sound galaxy of eminent faculty having specializations in thrust areas are always available to our students. There is an African proverb that says, "if you want to go fast, go alone and if you want to go far, go together". At NIT Srinagar, in the Department of Physics, we choose to go together. We look forward to meeting and working with you. If you have any questions regarding this brochure, please feel free to contact shah M A at shahji@nitsri.ac.in.

Once again, welcome and wish you a good start!

Dr. M. A. Shah
Programme Coordinator

National Institute of Technology Srinagar: A Profile

The National Institute of Technology, Srinagar (NIT), one of the leading institutes in north of the country, was established in 1960. In 2004, it had the unique distinction of becoming an Institute of National Importance under the NIT Act under the auspices of Ministry of Human Resources Development, Govt. of India.

Being fully residential, the campus located on the western bank of the Dal Lake near the famous Hazratbal Shrine, provides comfortable accommodation to all faculty and students. The institute has signed **Memorandum of Understanding (MOU)** with various national and international academies, professional and research institutes as well as industry to augment the learning process. These ties are a means for our students to gain valuable and relevant knowledge and experience, providing them with the building blocks for a successful future career. Students from all over the country epitomize a healthy amalgamation of different cultures, religions and languages on the campus and present a classical example of a mini cultural India.

The prestigious technical institute has ten departments which cater six postgraduate and ten undergraduate programmes besides offering Ph.D. degree in all Engineering and Science disciplines. Since its inception, the **Department of Physics** is offering the General Physics course Engineering Physics for all branches of B. Tech. students during first and second semesters, respectively. In addition, the department offers several electives to various branches.

The Department has full-fledged laboratories for research and offers Ph.D. program in Solid state physics, Materials science, Nanotechnology, Nuclear physics and in renewable energy sectors. Presently, the department has eight faculty members and the faculty has developed research collaborations with several premier institutions across the globe. In order to inculcate the academic culture, the department regularly organizes lecture/quiz competitions and invited talks by the eminent scientists. So far the department has produced maximum M. Phil. and Ph. D. scholars in the Institutes. Unending efforts are being made by the department to develop the well equipped research laboratories to cater the needs of master's programme which is likely to be approved. In this programme, we have offered intrinsically challenging and didactically inspiring courses.

The Institute overall has witnessed a remarkable growth in all sectors under the able guidance of our **Director Prof. Rakesh Sehgal** and his predecessors Prof Rajat Gupta and Hon'ble Chairperson Dr. M J Zarabi in launching this programme at NIT Srinagar.

Our mission

The Department embodies and delivers world class scholarship, education and research in Physical Science

We foster multidisciplinary working internally and collaborate widely externally.

We inculcate the highest degree of confidence, professionalism, academic excellence and ethics in our students.

Our Vision

- To harness the quality of our research capabilities to address the challenges of today and the future.
- To develop the next generation of Researchers, Scientists, Academics and skills they require to pursue their ambitions.
- To engage with the world and communicate the importance and benefits of science to society.

Programme Structure:

Entire two years Masters Programme has been divided into four semesters. In first year (two semesters) all the core courses have been introduced with more information with relevant updated topics with a view to link earlier (B. Sc.) programme. In second year, courses have been designed to accommodate more applied subjects (electives) and comprehensive project work in industry or any national laboratory of repute.

Duration of Course

The course is a full time two years programme of 100 credits which is perfect combination of theoretical and experimental studies in various field of Physics.

Ist Year: Semester I & II
2nd Year: Semester III & IV

Total number of seats: **Thirty One (31)**

Reservation for open, SC/ST, OBC and PH are as per Govt. of India rules. Please check web page of CCMN for various categories.

Eligibility Criteria:

Students for admission to M. Sc. Programme must satisfy the criteria:
A candidate must be graduate in Science with Physics as Major subject and must have secured at lest 60% marks or CGPA 6.5/10 or equivalent for OC/OBC/EWS/SF and for SC/ST/PWD candidates minimum marks are 50% or CGPA 5.5/10 at U.G Level from a recognized university/institution with valid JAM score/Institute entrance examination score..

Admission Procedure:

Admission is through CCMN. However, the left over seats are being filled by the institute through written test. Interested candidates satisfying the eligibility criteria will have to submit their application form in the prescribed format, which will be made available on the institute web page (www.nitsri.net). Applicant should be a citizen of India. Admission of foreign nationals, if any, shall be governed by the rules stipulated by the Government of India from time to time.

Two step processes to admit the students into M.Sc. programme shall be carried as:

1. Short listing of candidates as per eligibility.
2. Performance in written test examination.
3. Filling of vacant seat as per reservation guidelines.

The Scheme of Examination

The examination will be as per institute rules and shall be conducted in semester pattern with one midterm and end terms examination.

Examination Pattern

Mid Term Exam	End Term Exam	Class Assessment
30%	60%	10%

Objective of the Programme

The P.G Programme in Physics is designed to deliver a solid foundation in Physics and applied Physics with adaptability to a wide range of career objectives: Few are worth to mention:

(i) The course will not only give the scientific training and skills but will also help to develop the ability to diversify into broad science opportunities.

(ii) Since a strong emphasis on practical learning with extensive hands on experimental work throughout the course has been proposed. Therefore, it will help to apply learning from the class room to the Laboratories and to field.

(iii) The Department shall provide excellent opportunities for interdisciplinary studies and research in collaboration with the other institutions of the country and beyond.

Admission Procedure

The Admission shall be made purly on the basis of JAM score conducted by Government of India. The reaming vacant seats will be filled up through the institute entrance test and on the basis of merit.

Centralized Counselling for M.Sc./M.Sc. (Tech.) Admissions in NITs and CFTIs, 2020

(CCMN 2020)

Information Brochure

(May 17, 2020)

Excellence Through Science Education

https://ccmn.admissions.nic.in

Note:

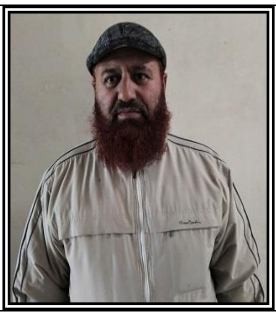
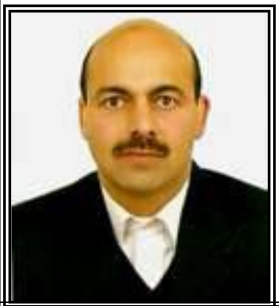
Please remain in touch with the CCMN web page for admissions.

NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR

(*An autonomous Institute of National Importance under the aegis of Ministry of Education, Govt. of India*)

Department of Physics

Faculty Information

S. No.	Faculty Name Specialization/Research Interest	S. No.	Faculty Name Specialization/Research Interest
1.	 **Prof. Mohd. Ikram** Material Science, Thin Films, Swift Heavy ion Irradiation, Nanoscience, Magnetism, EPR and Superconductivity	2.	 **Dr. Seemin Rubab** Renewable Sources of Energy, Nanoscience
3.	 **Dr. G.R. Khan** Nano Science, Atomic Physics, Fiber Optics	4.	 **Dr. Prince A. Ganai** Quantum Gravity, Blackhole Thermodynamics, Quantum Information, Glaxy Clustering, Theoretical Nuclear Physics
5.	 **Dr. M. A. Shah** Nano Science and Nanotechnology, Condensed Matter Physics Nano-Materials & their Applications	6.	 **Dr. Vijay Kumar** Functional Materials, Solid-State Luminescent Materials, Super-absorbents, Smart Materials
7.	 **Dr. Mohd Zubair Ansari** Experimental Solid State Physics, Nanotechnology Thin Films, Heterostructure, Semiconductor nanomaterials, Solar Cell, Photocatalysis & Water Splitting	8.	 **Dr. Harkirat Singh** Lightly Doped Superconducting Thin Films, Single Crystals, Quantum Information Processing, Magnetic Thin Films

Laboratories

S. No.	Semester	Laboratory Name	Faculty
1.	I	Solid State Physics	Dr. M. A. Shah
2.	I	Advanced Optics	Dr. H. Singh
3.	II	Electronics And Instrumentation	Dr. M. A. Shah
4.	II	Characterization	Dr. H. Singh
5.	III	Computational Physics	Dr. H. Singh
6.	III	Material Science	Dr. M. Ikram

Other Facilities:

1. Scanning Electron Microscope
2. X-Ray diffractometer
3. UV- Visible Spectrophotometer
4. Raman Spectrometer
5. Microwave Workstations

Collaborations with other Institutions/Universities:

The faculty of the department has collaborations with other prestigious universities and institutions of the country and outside for availing the research facilities, which are not available in the institution.

Based on the above specialization, the program objectives of M.Sc. Physics are:

1. To Impart a world class education in physical sciences

2. To understand the underlying physics in respective specializations, and, be able to teach and guide successfully.

3. To prepare students to take up challenges as globally competitive physicists/researchers in various domains of theoretical and experimental physics.

4. To nurture the creation of innovative and pertinent technologies and to transfer them to the industry for effective use

5. To apply the theoretical and experimental aspects of physics for futuristic applications

6. To train students in teamwork and in lifelong learning for continuous professional development.

7. To train our students to work for Sustainable Developments Goals (SDG)

Programme Structure

SEMESTER – I **Total Credits:**

S. No.	Course Code	Courses	L	T	P	Credits
1.	PSPHY 101	Mathematical Methods for Physics	3	1	0	4
2.	PSPHY 102	Classical Mechanics	3	1	0	4
3.	PSPHY 103	Quantum Mechanics	3	1	0	4
4.	PSPHY 104	Solid State Physics	3	1	0	4
Laboratories						
6.	PSPHY LB1	Solid State Physics Lab			4	2
7.	PSPHY LB2	Advanced Optics Laboratory			4	2
	Total		12	4	8	**20**

SEMESTER - II

S. No.	Course Code	Courses	L	T	P	Credits
1.	PSPHY 201	Classical Electrodynamics	3	1	0	4
2.	PSPHY 202	Solid State Electronics	3	1	0	4
3.	PSPHY 203	Thermodynamics and Statistical Mechanics	3	1	0	4
4.	PSPHY 204	Atomic and Molecular Physics	3	1	0	4
Laboratories						
6.	PSPHY LB3	Electronics and Instrumentation Lab.	0	0	4	2
7.	PSPHY LB4	Characterization Lab.	0	0	4	2
	Total		12	4	8	**20**

SEMESTER – III

S. No.	Course Code	Courses	L	T	P	Credits
1.	PSPHY 301	Condensed Matter Physics	3	1	0	4
2.	PSPHY 302	Nuclear and Particle Physics	3	1	0	4
3.	PSPHY 303	Computational Methods In Physics	3	1	0	4
4.	PSPHY EL	Choose one course from electives	3	1	0	4
Laboratories						
4.	PSPHYLB5	Computational Physics Lab.	0	0	4	2
5.	PSPHY LB 6	Materials Science Lab.	0	0	4	2
	Total		12	4	8	20

SEMESTER – IV

S. No.	Course Code	Courses	L	T	P	Credits
1	PSPHY PR01	Research Methodology/One optional	2	0	0	4
2	PSPHY PR02	Project/Dissertation and Viva voce	0	0	50	36
	Total					**100**

List of Electives course

(Students have to choose only elective as per choice)

S. No.	Course Code	Courses	L	T	P	Credits
1.	PSPHY EL01	Renewable Sources of Energy	3	1	0	4
2.	PSPHY EL02	Nanoscience and Nanomaterials	3	1	0	4
3.	PSPHY EL03	Atmospheric & Environmental Physics	3	1	0	4
4.	PSPHY EL04	Semiconductor Physics	3	1	0	4
5.	PSPHY EL05	Medical Physics	3	1	0	4
6.	PSPHY EL06	Solar Photovoltaics	3	1	0	4
7.	PSPHY EL07	Advanced Condensed Matter Physics	3	1	0	4
8.	PSPHY EL08	Quantum Field Theory	3	1	0	4
9.	PSPHY EL09	Relativity and Cosmology	3	1	0	4
10.	PSPHY EL10	Materials Science	3	1	0	4

First Semester

SEMESTER – I **Total Credits:**

S. No.	Course Code	Courses	L	T	P	Credits
1.	PSPHY 101	Mathematical Methods for Physics	3	1	0	4
2.	PSPHY 102	Classical Mechanics	3	1	0	4
3.	PSPHY 103	Quantum Mechanics	3	1	0	4
4.	PSPHY 104	Solid State Physics	3	1	0	4
Laboratories						
6.	PSPHY LB1	Solid State Physics Lab			4	2
7.	PSPHY LB2	Advanced Optics Laboratory			4	2
	Total		12	4	8	**20**

<table>
<tr><td>PSPHY 101</td><td colspan="2">Mathematical Methods For Physics</td><td>C L T P
4 3 1 0</td></tr>
<tr><td>Course Objectives</td><td colspan="3">The main objective of this course is to familiarize students with a range of mathematical methods that are essential for solving advanced problems in theoretical physics.
1. Basic concepts of vector algebra and vector calculus.
2. Understand the matrices and Tensors.
3. Introduce to complex analysis and apply Cauchy–Riemann conditions on complex function.
4. Solve first order and higher differential equations.</td></tr>
<tr><td>Syllabus</td><td colspan="3">Vector Calculus: Vector analysis in curved coordinates, Orthogonal coordinates in R3, Special Coordinates system- Cylindrical and spherical coordinates, Laplacian in cylindrical and spherical coordinates, Vector integration- line, surface and volume- Gauss, Stokes and Greens theorem.

Linear Algebra and Tensor: Matrices, Eigenvalues and eigenvectors, Cayley-Hamilton theorem, Tensor analysis, Rank of a tensor, Metric tensor, Summation convention, Contraction theorem, Direct Product, Levi-Civita Symbol, Kronecker and alternative tensor, Christoffel symbol.

Complex Analysis: Functions of Complex Variable, Analytic Properties, Cauchy–Riemann Conditions, Cauchy’s Integral Theorem, Cauchy’s Integral Formula, Taylor series, Laurent Expansion, Calculus of Residues and evaluation of Integral.

Differential Equations: First and second order differential equations, Separation of Variables, Dirac Delta function, Bessel Functions, Bessel Functions of the First Kind, Hermite Functions, Laguerre Functions, Laguerre functions.</td></tr>
<tr><td>Expected Outcome</td><td colspan="3">• Upon completion of the course, the student should be able to understand basic theory of: Vector and tensor analysis, Functions of complex variables,
• Student be able to apply methods of functions of complex variables for calculations of integrals: Expand functions in Taylor’s Series, Work with vectors and Work with tensors.

Skills: Students will be aware about numerical methods and their applications in various fields.</td></tr>
<tr><td>Text Book</td><td colspan="3">1. L.A. Pipes and L R. Harvil, Applied Mathematics for Engineers and Physicists, Tata McGraw-Hill (1970).
2. E. Kreyszig, Advanced Engineering Mathematics, 8th edition, John Wiley & Sons Inc. (1999).
3. H.K. Das and Rama Verma, Mathematical Physics, 8th edition, S Chand (2018).</td></tr>
<tr><td>Reference</td><td colspan="3">1. George Arfken, Hans Weber and Harris, Mathematical Methods for Physicists, 7th edition, Academic Press (2012).
2. Mathematical Physics by Rajput B.S. Pragati Prakashan, Meerut Matrices and Tensors in Physics by Joshi A.W., New Age International Publishers, New Delhi.</td></tr>
<tr><td>Faculty</td><td>Dr. M. Z. Ansari</td><td>Contact</td><td>mohdzubair@nitsri.ac.in</td></tr>
</table>

<table>
<tr><td>PSPHY 102</td><td colspan="3">Classical Mechanics</td><td>C: 4 | L: 3 | T: 1 | P: 0</td></tr>
<tr><td>Course Objectives</td><td colspan="4">1. Students will be able to define basics of classical mechanics.
2. Students will be able to explain central forces.
3. Students will be able to understand Hamilton’s principle.
4. Students will be able to evaluate Canonical Transformations and Poisson’s brackets.</td></tr>
<tr><td>Syllabus</td><td colspan="4">Newtonian mechanics and its limitations. Constrained motion. Constraints and their classification. Principle of virtual work. D’ Alembert’s principle. Generalized coordinates, Generalized momenta and energy, Cyclic or ignorable coordinates. Lagrange’s equations and applications.

Central force. Definition and properties of central force. Two-body central force problem. Stability of orbits. Conditions for closure. General analysis of orbits. Kepler’s laws. Kepler’s equation.

Principle of least action. Hamilton’s principle. The calculus of variations. Derivation of Hamilton’s equations of motion for holonomic systems from Hamilton’s principle. Hamilton’s principle and characteristic functions.

Canonical Transformations, Generating functions. Poisson brackets, Poisson’s Theorem. Invariance of PB under canonical transformations, Angular momentum PBs, Hamilton-Jacobi equation. Connection with Classical Mechanics canonical transformation. Problems. Small oscillations, Normal modes and coordinates. Problems.</td></tr>
<tr><td>Expected Outcome</td><td colspan="4">Students are expected to understand need of classical mechanics in solving problems relate to classical systems.
Skills: The candidate should be able to do extensive calculations in solving problems related to classical systems.</td></tr>
<tr><td>Text Book</td><td colspan="4">1. H. Goldstein, C. Poole and J. Safko, Classical Mechanics, 3nd edition, Addison & Wesley (2000).
2. L.D. Landau and E.M. Lifshitz, Mechanics, Buttorworth-Heinemann (1976).</td></tr>
<tr><td>Reference</td><td colspan="4">1. W. Greiner, Classical Mechanics – Point particles and Relativity, Springer-Verlag (1989).
2. N.C Rana and P.S Joag, Classical Mechanics.</td></tr>
<tr><td>Faculty</td><td>Dr. Harkirat Singh</td><td>Contact</td><td colspan="2">harkirat@nitsri.ac.in</td></tr>
</table>

PSPHY 103	**Quantum Mechanics**	C 4	L 3	T 1	P 0
Course Objectives	The course is an introduction to the basic concepts of Quantum mechanics and is aimed to build a theoretical as well as experimental understanding of the subject. 1. Basic concept of vector space. 2. Dirac bra-ket formalism to present the principles of Quantum Mechanics in a general context. 3. Analytic solutions to the Schrodinger equation for a variety of potentials in one, two and three dimensions. 4. The role of symmetries as the underlying principle of Quantum Mechanics will be emphasized throughout the course.				
Syllabus	Linear vector space – State space, Dirac notation and Representation of State Spaces, Concept of Kets, Bras and Operators, Uncertainty Relations, Commutation and Compatibility, Change of basis, Unitary operators. State function and its interpretation, Matrix Representation of State Vectors and operators, Continuous Basis. Relation between a State Vector and its Wave function. Solution of the Linear Harmonic Oscillator with Operator Method, Coherent States. Schrödinger equation and its applications-In one dimensional consideration-Particle in one-dimensional potential well (finite and infinite depth) and its energy states; Linear harmonic oscillator; Free particle wave function; Angular momentum and the eigen functions; Energy states associated wave functions of Hydrogen atom; Expression of Bohr radius. Approximation methods - Time-independent perturbation theory for non-degenerate and degenerate states. Applications: Anharmonic oscillator, Helium atom, Stark effect in hydrogen atom, Variational methods: Helium atom. Generalised angular momentum- Infinitesimal rotation, Generator of rotation, Commutation rules, Matrix representation of angular momentum operators, Spin, Pauli spin matrices, Rotation of spin states, Coupling of two angular momentum operators, Clebsch Gordon coefficients, Symmetries- Irreducible spherical tensor operators, Wigner-Eckert theorem and its applications, Space inversion,				
Expected Outcome	On completion of this course, the student will be able to: 1. Use the superposition principle to predict experimental outcomes for measure-ment of observables on simple quantum systems. Apply the uncertainty principle and heuristic arguments to obtain rough de-scriptions of quantum systems. **Skills:** The student should identify and understand the kinds of experimental results which are incompatible with classical physics and which required the development of a quantum theory of matter and light.				
Text Book	1. Introduction to Quantum Mechanics – David J. Griffiths, Second Edition, Pearson Prentice Hall 2005. 2. Quantum Mechanics – V.K. Thankappan, Second Edition, Wiley Eastern Limited, 1993.				
Reference	1. Quantum Mechanics- L.I. Schiff, Third Edition, Mc Graw Hill Book Company, 1955. 2. Quantum Mechanics – B.H. Bransden and C.J. Joachain, Second Edition, Pearson Education, 2007.				
Faculty	Dr. P A Ganai	Contact	princeganai@nitsri.ac.in		

<table>
<tr><td>PSPHY 104</td><td colspan="3">Solid State Physics</td><td>C
4</td><td>L
3</td><td>T
1</td><td>P
0</td></tr>
<tr><td>Course Objectives</td><td colspan="7">The course is an introduction to the concepts required for learning solid state physics and shall enable the student to understand
1. Basics of Crystal Structure and various associated phenomenas
2. Lattice vibrations (Phonon theory)
3. Band Theory of solids and different models
4. Properties of materials</td></tr>
<tr><td>Syllabus</td><td colspan="7">The crystal Physics, X-ray diffraction, neutron and electron diffraction in crystals, Classifications of Bravais lattice on the basis of geometry of unit cell and symmetry, Directions & Planes, Reciprocal lattice, Crystal Growth Techniques and crystal defects.
Phonon: Phonon bands and band gaps, Modes of vibration and density of states, Lattice vibrations, Vibrations of a 1D monotonic lattice, Phonons, Phonon bands to heat capacity
Free electron theory; its advantages and limitations.Fermi energy and Fermi surface. Electrical conductivity, Thermal conductivity in metals, Thermionic emission, Quantum free electron theory, Electrical conductivity and temperature dependence of electrical resistivity.
Energy bands in solids, Bloch Theorem, Kronig-Penny model, Brillouin zones, The Energy gap and the calculation of energy bands. Metals, insulators and semiconductors,
Shortly on the different properties associated with solid state materials.</td></tr>
<tr><td>Expected Outcome</td><td colspan="7">Students expected to know physical properties of solid materials, with an emphasis on the crystalline state and are also expected to understand low dimensional physics.
Skills: On completion of this course, the candidate should be able to describe the properties of materials and should address challenges in the field of solid state Physics.</td></tr>
<tr><td>Text Book</td><td colspan="7">1. Introduction to Solid State Physics, C. Kittel, 8th ed; John Wiley & Sons (2005)
2. Solid State Physics, M A Wahab. Naroosa Publishing House, New Delhi; (2000)
3. Solid State Physics, N. W. Ashcroft and N. D. Mermin; Harcourt Asia Pte. Ltd. (2001)</td></tr>
<tr><td>Reference</td><td colspan="7">1. O. Pillay: Solid State Physics, New Age International Publishers 2015
2. M. Ali Omar, Elementary Solid State Physics, Pearson 2006.
3. Shah M A and Ahmad T, Principles of Nanoscience and nanotechnology, IK International Pvt Ltd, New Delhi 2020</td></tr>
<tr><td>Faculty</td><td>Dr. M A Shah</td><td>Contact</td><td colspan="5">shahji@nitsri.ac.in</td></tr>
</table>

Laboratories

PSPHY LB01	Solid State Physics Lab	C	L	T	P
		2	0	0	4
	1. To determine the band gap of given semiconductor crystal using four probe method.				
	2. To determine the Hall coefficient for given semiconductor and study its field dependence.				
	3. Study of frequency dependence of dielectric constant for a given sample.				
	4. To study hysteresis of ferromagnetic material.				
	5. To Study the Thermo luminescence of F-Centers in Alkali Halides Crystals.				
	6. To study the morphology of a sample using SEM and to study elemental analysis by EDX method.				
	7. To measure the frequency dependence of dielectric constant of a ferroelectric material ($BaTiO3$) using an 'Impedance meter'.				
	8. Measurement of resistivity of very low to highly resistive samples by four probe method at different temperatures.				
	9. To study the superconducting transition of YBCO superconductor				
	10. Measurement of magnetoresistance of semiconductor.				
Faculty	Dr. M A Shah	Contact	shahji@nitsri.ac.in		

PSPHY LB02	Advanced Optics Lab	C	L	T	P
		2	0	0	4
Lab Objectives	1. Students will be able to understand concepts of optics. 2. Students will be able to apply concepts of optics. 3. Students will be able to evaluate various optical parameters. 4. Students will be learn experimental practices.				
	1. Determination of line width of a laser using monochromator.				
	2. Diffraction of light due to a straight edge				
	3. Thickness of the enamel coating on a wire - by diffraction.				
	4. Production and analysis of linearly, circularly and elliptically polarized light				
	5. Measurement of screw parameters using a laser beam.				
	6. Using Michelson's interferometer for the determination of thickness of film and its refractive index.				
	7. Measurement of coherence length of laser using Michelson interferometer.				
	8. Construction and reconstruction of an object using holography.				
	9. Diffraction of light by straight edge.				
	10. Mach-Zehnder Interferometer using a He-Ne laser.				
Faculty	Dr. H. Singh	Contact	harkirat@nitsri.ac.in		

Second Semester

SEMESTER - II

S. No.	Course Code	Courses	L	T	P	Credits
1.	PSPHY 201	Classical Electrodynamics	3	1	0	4
2.	PSPHY 202	Solid State Electronics	3	1	0	4
3.	PSPHY 203	Thermodynamics and Statistical Mechanics	3	1	0	4
4.	PSPHY 204	Atomic and Molecular Physics	3	1	0	4
Laboratories						
6.	PSPHY LB3	Electronics and Instrumentation Lab.	0	0	4	2
7.	PSPHY LB4	Characterization Lab.	0	0	4	2
	Total		12	4	8	**20**

<table>
<tr><td>PSPHY 201</td><td>Electrodynamics</td><td>C
4</td><td>L
3</td><td>T
1</td><td>P
0</td></tr>
<tr><td>Course Objectives</td><td colspan="5">The course is an introduction to the concepts required for learning classical electrodynamics and shall enable the student to understand
1. Concepts of fields and potentials
2. Electrostatic boundary value problems
3. Magnetic effects of current & electromagnetic induction
4. Maxwell’s equations & EM-waves in bounded media</td></tr>
<tr><td>Syllabus</td><td colspan="5">Electrostatics Coulomb’s law, Electric field, Gauss’s law, applications of Gauss’s law, Electric Potential, Poisson’s equation and Laplace’s equation, Method of Images, Multipole expansion Electrostatic fields in matter: Dielectrics, Polarization, Field inside a dielectric, Electric displacement, Linear dielectrics.

Magnetostatics, Biot-Savart Law, Divergence and Curl of B, Ampere’s law and applications of Ampere’s law, Magnetic vector potential, Multipole expansion. Magnetostatic fields in MatterFaraday’s law, Maxwell’s displacement current, Differential and integral forms of Maxwell’s equations.

Scalar and vector potentials, gauge transformations, Coulomb and Lorentz Gauge; Maxwell’s equations in terms of potentials. Energy and momentum in electrodynamics. Electromagnetic waves in non-conducting media: Dispersion in non-conductors, free electrons in conductors and plasmas. Guided waves. Electromagnetic radiation, Retarded potentials, Electric dipole radiation, magnetic dipole radiation.

Radiation from a point charge: Lienard-Wiechart potentials, fields of a point charge in motion, power radiated by a point charge. Electrodynamics and Relativity: Review of special theory of relativity, Lorentz transformations, Minkowski four vectors, Transformation of electric and magnetic fields under Lorentz transformations, field tensor, invariants of electromagnetic field, Covariant formulation of electrodynamics, Lorentz force on a relativistic charged particle.</td></tr>
<tr><td>Expected Outcome</td><td colspan="5">Students will have achieved the ability to:
1. Student is expected to know the basic principles governing the charges in motion and use Maxwell equations in analyzing the electromagnetic field due to time varying charge and current distribution.
2. Properly handle the theoretical aspects regarding the moving charge and its interactions.
Skills: The course is aimed at enhancing problem-solving and mathematical skills by requiring students to apply their mathematical skills and physics understanding to a variety of situations and systems</td></tr>
<tr><td>Text Book</td><td colspan="5">1. Introduction to Electrodynamics – David J. Griffiths, Second Edition, Prentice Hall India, 1989.
2. Classical Electrodynamics – J.D. Jackson, Fourth Edition, John Wiley & Sons, 2005.</td></tr>
<tr><td>Reference</td><td colspan="5">1. J. D. Jackson – Classical Electrodynamics.
2. R.G. Brown. – Classical Electrodynamics.</td></tr>
<tr><td>Faculty</td><td>Dr. P A Ganai</td><td colspan="2">Contact</td><td colspan="2">princeganai@nitsri.ac.in</td></tr>
</table>

<table>
<tr><td>PSPHY 202</td><td colspan="3">Solid State Electronics</td><td>C L T P
4 3 1 0</td></tr>
<tr><td>Course Objectives</td><td colspan="4">The aim of this course is to introduce the student to the fundamentals of solid state electronics and devices
1.Basics of semiconductors & band structure
2.Pn-junction: operation & applications
3.Transistor: operation & characteristics
4.Digital circuits: operation & devices</td></tr>
<tr><td>Syllabus</td><td colspan="4">Bonds and Energy bands in solids, Elemental and compound semiconductors, Direct and indirect semiconductors, Charge Carriers and doping, Equilibrium concentration of electrons and holes, mobility and the effect of temperature on mobility, Carrier transport in semiconductors
PN junctions, contact potential, electrical field, potential and charge density at the junction, energy band diagram, minority carrier distribution, Ideal diode equation, Light Emitting Diodes, Solar Cells, characteristics and applications.
Bipolar transistors, input/output characteristics, MOSFET, Nano MOSFET performance, Device Fabrication, Emerging research devices and architectures, Shortly on Lasers and
Digital electronics, Boolean algebra, Basic principles and operations of universal gates and flip-flops.</td></tr>
<tr><td>Expected Outcome</td><td colspan="4">Students should perform project work through engineering applications to the satisfactory standard and should be able to carry research in semiconductor device applications.
Skills: The candidate should be able to:
Understand the underlying the operating principles of important electronic and photonic devices used in day to day life.</td></tr>
<tr><td>Text Book</td><td colspan="4">1. Ben G. Streetman and Sanjay Kumar Banerjee, Solid State Electronic Devices, Pearson, 6/e, 2010
2. Sze S.M., Physics of Semiconductor Devices, John Wiley, 3/e, 2005
3. Donald Nearman, Semiconductor Physics and Devices 3/e Mc Graw Hill, 2012</td></tr>
<tr><td>Reference</td><td colspan="4">1. Pierret, Semiconductor Devices Fundamentals, Pearson, 2006
2. M. Razeghi, Fundamentals of Solid State Engineering, 3rd ed., Springer, 2009.
3. Shah M A and Shah K A, Science of Small, Wiley2019</td></tr>
<tr><td>Faculty</td><td>Dr. M A Shah</td><td>Contact</td><td colspan="2">shahji@nitsri.ac.in</td></tr>
</table>

<table>
<tr><td rowspan="2">PSPHY 203</td><td rowspan="2">Thermodynamics and Statistical Mechanics</td><td>C</td><td>L</td><td>T</td><td>P</td></tr>
<tr><td>4</td><td>3</td><td>1</td><td>0</td></tr>
<tr><td>Course Objectives</td><td colspan="5">1. Students will be able to define concept to entropy.
2. Students will be able to explain concept of ensembles.
3. Students will be able to classify classical and quantum statistics.
4. Students will be able to argue on concept of phase transition.</td></tr>
<tr><td>Syllabus</td><td colspan="5">Connection between statistics and thermodynamics; Concept of microstates phase space and its connection to Entropy; Classical Ideal Gas and the Maxwell Boltzmann Distribution, Entropy of mixing and Gibbs Paradox.

Liouvilles Theorem, Microcanonical Ensemble, Canonical Ensemble and Partition Function calculation for various systems; Energy fluctuations in the Canonical Ensemble; Grand Canonical Ensemble.

Quantum Statistics and calculation of the Density matrix for various systems; calculation of the Bose-Einstein and Fermi-Dirac Distribution for a quantum Ideal Gas; Thermodynamic behaviour of an Ideal Bose Gas, Bose-Einstein Condensate; Thermodynamic behaviour of an ideal Fermi gas.

Phase Transitions: General concepts of phase transitions, order parameter, continuous transition, Landau theory of phase transition, concept of critical phenomena, critical exponents, Ising model and Van der Waals gas, exact solution of the Ising model in 1D</td></tr>
<tr><td>Expected Outcome</td><td colspan="5">Students are expected to understand basics of statistical mechanics and its implementation in understanding quantum systems

Skills. The candidate should be able to:

Do extensive calculations to solve problems related to quantum systems.</td></tr>
<tr><td>Text Book</td><td colspan="5">1. F. Reif, Fundamentals of Statistical and Thermal Physics, International Students edition, Tata McGraw-Hill (1988).
2. R. K. Pathria, Statistical Mechanics</td></tr>
<tr><td>Reference</td><td colspan="5">1. K. Haung, Statistical Mechanics, Wiley Eastern (1991).
2. R. Kubo: Statistical Mechanics.
3. F.W. Sears and G.L. Salinger, Thermodynamics, Kinetic Theory and Statistical Thermodynamics, 3rd edition, Narosa Publishing House (1998).</td></tr>
<tr><td>Faculty</td><td>Dr. Harkirat Singh</td><td>Contact</td><td colspan="3">harkirat@nitsri.ac.in</td></tr>
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<table>
<tr><td>PSPHY 204</td><td colspan="3">Atomic And Molecular Physics</td><td>C L T P
4 3 1 0</td></tr>
<tr><td>Course Objectives</td><td colspan="4">The course aim to give fundamental insight of atomic and Molecular Physics.
1. Students will be able to understand the structure of Hydrogen atom.
2. Students will be able to understand the spectra of the Helium Atom.
3. Students will be able to understand the angular momentum in many electron atoms.
4. Students will be able to understand the Molecular spectroscopy.</td></tr>
<tr><td>Syllabus</td><td colspan="4">Hydrogen Atom Structures: Solution of Schrödinger's Equation for one Electron System, Quantum Numbers (n, l, m) and Wave Function of the H Atom, Comparison With the Bhor's Model, Relativistic Correction of Energy Terms, The Electron Spin, The Stern-Gerlach Experiment, Numerical Problems.
Two Valance Electron Atom: The Helium Atom, Approximation Models, Symmetry of the Wave Function, Consideration of Electron Spin, Pauli's Exclusion Principle, Spectroscopic Terms and Selection Rules, Energy Levels of the Helium Atom, Helium Spectrum, Numerical Problems.
Angular Problems In Many-Electron Atoms: Coupling Schemes for Electronic Angular Momenta, The LS-Coupling Approximation, Allowed Term in LS Coupling. Interaction with External Field: Zeeman (Normal and Anomalous), Paschen-Back and Stark Effects, Numerical Problems.
Molecular Physics: Molecular Structure and Molecular Spectra, Rotational, Vibrational, Rotational-Vibrational and Electronic Spectra of Di-atomic Molecules, Selection Rules, ESR Spectroscopy: Introduction, Electron-Electron Coupling, Infrared Spectroscopy: Raman Spectra, Numerical Problems.</td></tr>
<tr><td>Expected Outcome</td><td colspan="4">Understanding of two electron system as helium atom. Interpretation of L-S, and J-J coupling and interaction with external fields
Skills: Upon successful completion of the course, student should be able to know:
Solution Schrödinger equation for the hydrogen atom and interpretation of quantum numbers. Spin-orbit interaction and spectroscopic terms.</td></tr>
<tr><td>Text Book</td><td colspan="4">1. Wolfgang D, Atoms, Molecules and Photons, 3rd edition, Springer.
2. C.N. Banwell, Fundamentals of Molecular Spectroscopy, 4th edition, McGraw-Hill, New York.
3. Manas Chanda, Atomic Structure and Chemical Bond, Tata McGraw-Hill, New Delhi.</td></tr>
<tr><td>Reference</td><td colspan="4">1. B.H Bransden and C.J Joachain: Physics of atoms and Molecules.
2. Raj Kumar, Atomic and Molecular Physics, Campus Book.</td></tr>
<tr><td>Faculty</td><td>Prof. M. Ikram</td><td>Contact</td><td colspan="2">ikram@nitsri.ac.in</td></tr>
</table>

Laboratories

PSPHY LB03	Electronics And Instrumentation Lab			C	L	T	P
				2	0	0	4
	1. To study the gain characteristics of a double stage RC coupled BJT amplifier.						
	2. To study the drain, transfer characteristics of a JFET.						
	3. To study the input and output characteristics of a differential amplifier.						
	4. To study MOSFET as output power amplifier.						
	5. Design and performance study of inverting, non-inverting and unity gain, differentiator, integrator amplifier using op-amp.						
	6. Design and performance study of Schmidt trigger circuit.						
	7. Design and performance study of astable multivibrator and mono-stable multivibrator.						
	8. Design and performance study of active filters (Low pass, high pass, band pass, band reject).						
	9. Combinational circuits: Adders, multipliers, magnitude comparators.						
	10. Sequential circuits: Flip flops, counters, shift registers. (Ripple counter with D-type flip-flops; J-K flip flop and its application to counting).						
Faculty	Dr. M A Shah	Contact	shahji@nitsri.ac.in				

PSPHY LB04	Characterization Lab			C	L	T	P
				2	0	0	4
Lab. Objectives	1. Students will learn handling of equipments 2. Students will be able to classify various characterization techniques. 3. Students will be able to explain basic concepts and working of equipments. 4. Students will learn basic experimental practices.						
	1. Structural determination of powdered crystalline materials by XRD.						
	2. Surface morphology of the materials by SEM.						
	3. Characterization of semiconductors: Determination of number of charge carriers, mobility.						
	4. Study of Dielectric Constant and Measure Curie temperature of Ferroelectric Ceramics.						
	5. Apparatus for Measurement of Susceptibility of Paramagnetic Substance in the form of Solution by Quincy's Tube Method.						
	6. Mossbauer Spectrometer.						
	7. Ultrasonic testing apparatus.						
	8. Experimental methods for gamma-ray (G.M. Counter).						
	9. Determination of the g of DPPH by Electron Spin Resonance Spectrometer (ESR).						
	10. Determination of band gap of semiconducting materials by UV- Visible spectrometer.						
Faculty	Dr. Harkirat Singh	Contact	harkirat@nitsri.ac.in				

Third Semester

SEMESTER – III

S. No.	Course Code	Courses	L	T	P	Credits
1.	PSPHY 301	Condensed Matter Physics	3	1	0	4
2.	PSPHY 302	Nuclear and Particle Physics	3	1	0	4
3.	PSPHY 303	Computational Methods In Physics	3	1	0	4
4.	PSPHY EL	Choose one course from electives	3	1	0	4
Laboratories						
4.	PSPHYLB5	Computational Physics Lab.	0	0	4	2
5.	PSPHY LB 6	Materials Science Lab.	0	0	4	2
	Total		12	4	8	20

PSPHY 301	**Condensed Matter Physics**	C	L	T	P
		4	3	1	0
Course Objectives	The course aim is to understand the general aspects of the condensed matter physics. 1. Students will be able to understand the Electronic transport properties of solids. 2. Students will be able to understand the Magnetic properties of solids and applications. 3. Students will be able to understand the Optical properties. 4. Students will be able to understand the Basics of the superconductivity and applications.				
Syllabus	**Transport Properties:** Boltzmann Equation; Relaxation Time Approximation; General Transport Coefficients; Electronic Conduction in Metals; Thermoelectric Effects; Transport Phenomena in Magnetic Field: Magnetoresistance; Magnetotransport; Classical Theory of Magnetoconductivity; Hall Effect and Quantum Hall Effect; Numerical Problems. **Magnetism:** Magnetic Properties of Insulators, Langevin Diamagnetism and Van Vleck Paramagnetism, Curie Paramagnets and Curie-Weiss Ferromagnets, Neel Antiferromagnets, Heisenberg model; Spin Waves, Ising Model; Elements of Magnetic Properties of Metals, Landau Diamagnetism, Pauli Paramagnetism, Stoner Ferromagnetism; Magnetic Resonance; NMR And EPR, Numerical Problems. **Optical Processes And Exitons**: Optical Reflectance: Kramers-Kronig Relations; Electronics- Interrand Transitions; Exitons: Frankel Exitons; Weakly Bound Exitons; Exiton Condensation into Electron-Hole Drops; Raman Effect in Crystals; Numerical Problems. **Superconductivity:** History, General Properties, Measurements; Critical Field; Temperature, Current; Meissner Effect; Type-I and Type-II Superconductors; London Equation; Penetration Depth; Optical Properties; Cooper Pairing and BCS Theory; Ginzburg-Landau Theory; Flux Quantization; Super current Tunneling; DC And AC Josephson Effects; High-Tc Superconductors, Numerical Problems.				
Expected Outcome	Upon successful completion of the course, student should be able to know: 1. To introduce the general aspects of the electronic transport phenomena. 2. To introduce the general aspects of the magnetic properties of solids.				
Text Book	1. Principles of Condensed Matter Physics: P.M. Chaikin and T.C.Lubensky. 2. Principles of the theory of solids: J.M Ziman				
Reference	1. Solid State Physics: Ashcroft & Mermin. 2. Solid State Physics: A. J. Dekker, Macmillan, New Ed. 3. Kittel C, Introduction to solid state physics, 8th edition (Wiley Eastern Ltd.)				
Faculty	Prof. M. Ikram	Contact	ikram@nitsri.ac.in		

PSPHY 302	Nuclear and Particle Physics	C 4	L 3	T 1	P 0
Course Objectives	The course aim is to understand the general aspects of the nuclear and particle physics and shall enable the student to understand 1. Basics of nuclear structure and properties 2. Interaction of particles with matter 3. Particle accelerators and applications 4. Standard model				
Syllabus	Basic nuclear properties, Nuclear size and distribution of nucleons, Energies of nucleons in the nucleus, Angular momentum, Parity and symmetry, Magnetic dipole moment and electric quadrupole moment, Energy levels and mirror nuclei. Characteristics of nuclear forces - Effect of Pauli's exclusion principle, Magnetic dipole moment and electric quadrupole moment of deuteron -The tensor forces. Interaction of charged particles with matter. Stopping power and raige. Detectors for energetic charged particles; detector; Bubble chamber; Nuclear emulsions. Composite relations. Identification of particles. Need for accelerator of charged particles, Classification of types of accelerators, Proton Synchrotron, Betatron; alternating gradient accelerator, Colliding beam accelerator. Different types of reactions, Quantum mechanical theory, Resonance scattering, Compound nucleus formation, Statistical theory of nuclear reactions and evaporation probability. Classification and properties of elementary particles, Leptons, Baryons, mesons particles and antiparticles excited states and resonances. Various types of interactions - gravitational, electromagnetic, and weak and strong interactions and their mediating quanta, Conservation rules in fundamental interactions. Charge symmetry and charge independence, Parity and charge conjugation, strangeness and decay modes, Isospin and its conservation. Idea of eight fold way and quarks.				
Expected Outcome	On completion of this course, the student will be able to: 1. Apply knowledge of core concepts in physics to more advanced topics in nuclear and particle physics. 2. Formulate solutions to problems in nuclear and particle physics involving new concepts with limited guidance. **Skills:** The student should be able to summarize current thinking in nuclear and particle physics in a variety of written and oral forms, both alone and in collaboration with others.				
Text Book	1. Heral Enge, Introduction to Nuclear Physics, Addison Wesley (1981). 2. D.C. Tayal, Nuclear Physics, 4th edition, Himalaya House, Bombay (1980).				
Reference	1. A.D. Helfrick and W.D.Cooper: Modern Electron Instrumentation and Measurement Techniques. 2. Chaikin P M and Lubensky T C, Cambridge University Press.				
Faculty	Dr. P. A. Ganai	Contact	princeganai@nitsri.ac.in		

<table>
<tr><td>PSPHY 303</td><td colspan="3">Computational Methods in Physics</td><td>C: 4   L: 3   T: 1   P: 0</td></tr>
<tr><td>Course Objectives</td><td colspan="4">1. Students will be able to design MATLAB algorithms.
2. Students will be able to determine roots of equation by writing MATLAB codes.
3. Students will be able to calculate interpolation by writing MATLAB codes.
4. Students will be able to evaluate numerical differentiation and integration by writing MATLAB codes.</td></tr>
<tr><td>Syllabus</td><td colspan="4">Introduction to MATLAB: Brief introduction, installation of MATLAB, Use of MATLAB, key features; MATLAB Software: MATLAB window, command window, Workspace, command history, working with the MATLAB user interface, basic commands, assigning variables, operation with variables; Data files and types.

Determining roots of the equation by Bisection and Newton Raphson Method, Matrix manipulation: Finding transpose, determinant and inverse, solution of simultaneous method by Gauss elimination method, Gauss Seidel iteration method.

Interpolation, Newton's formula for forward and backward interpolation, Divided difference, symmetry of divided differences, Newton's general interpolation formula, Lagrange's interpolation formula, cubic splines, least square approximation, interpolation in multidimension.

Numerical differentiation and integration, Trapezoidal rule, Simpson 1/3 and Simpson 3/8 rule, Solution of ordinary differential equation: Euler's method, modified Euler's method and Runge-Kutta method, system of coupled first order ordinary differential equations.</td></tr>
<tr><td>Expected Outcome</td><td colspan="4">Students are expected to understand basics of MATLAB algorithms and its implementation in solving computational problems

Skills. The candidate should be able to:

Write MATLAB codes to solve computational physics problems.</td></tr>
<tr><td>Text Book</td><td colspan="4">1. N. Giordano and H Nakanishi, Computational Physics, Pearson Prentice Hall, NJ.
2. Srimanta Pal, Numerical methods: Principles, Analysis and Algorithms, Oxford University Press.</td></tr>
<tr><td>Reference</td><td colspan="4">1. Joe D. Hoffman, Numerical methods for scientists and engineers, Marcel Dekker Inc., New York
2. Scarbrough James B, Numerical Mathematical Analysis, Oxford and IBH Publishing Company, New Delhi</td></tr>
<tr><td>Faculty</td><td>Dr. Harkirat Singh</td><td>Contact</td><td colspan="2">harkirat@nitsri.ac.in</td></tr>
</table>

Laboratories

PSPHY LB05	Computational Physics Lab		C 2	L 0	T 0	P 4
Lab. Objectives	1. Students will learn to use MATLAB software. 2. Students will be able to apply numerical techniques to write MATLAB codes. 3. Students will be able to solve scientific problems using MATLAB codes. 4. Students will be able to execute simulation of scientific problems.					
	1. Write MATLAB script to simulate the decay of radioactive nucleus.					
	2. Write MATLAB script for the numerical solution of equation of motion for a simple pendulum using the Euler method.					
	3. Write MATLAB script for the numerical solution of equation of motion for a simple pendulum using the Runge-Kutta method.					
	4. Write a MATLAB script for the numerical solution of damped pendulum.					
	5. Write a MATLAB script to simulate the planetary motion of earth around the sun.					
	6. Write a MATLAB script to simulate the random walk.					
	7. Write a MATLAB script to solve time dependent Schrodinger equation in 1D for particle in a box problem.					
	8. Write a MATLAB script to simulate the Ising model of a ferromagnet.					
Faculty	Dr. Harkirat Singh	Contact	harkirat@nitsri.ac.in			

PSPHY LB06	Material Science Lab		C 2	L 0	T 0	P 4
Lab. Objectives	To get accustomed with the practical applications of the principles of x-rays for determining the particle size/grain size estimation by Scherrer formula of the crystallite.					
	1. To study the temperature dependence of Hall coefficient of a given semiconductor.					
	2. Determination of Band gap of a given semiconductor material by four probe technique.					
	3. Design/fabrication of a temperature controller and to study the performance of the designed controller using PID Controlled Oven.					
	4. Determination of Lattice parameters, particles sizes etc. of different powder samples of bulk-/nano-systems (ferrite, α-Fe2O3, γ-Fe_2O_3) using X-ray diffractograms.					
	5. Determination of Miller indices and lattice parameter of an unknown powder material by x-ray diffraction.					
	6. Phase identification of an unknown sample by x-ray diffraction.					
	7. Determination of particle size and lattice strain of an unknown powder specimen applying marq2 software and Scherrer equation.					
	8. Preparation of nanocrystalline powder specimen by ball milling: analysis of their x-ray spectra and particle size estimation by Scherrer formula.					
	9. Study of porosity and grain size of thin film and powder sample by SEM.					
Faculty	Prof. M. Ikram	Contact	ikram@nitsri.ac.in			

Electives

PSPHY EL 01	Renewable Sources of Energy	C: 4, L: 3, T: 1, P: 0		
Course Objectives	The course aim is to understand the general aspects of the renewable sources of energy and shall enable the student to understand 1. Basics of Energy, environment and development Nexus 2. Solar thermal energy harvesting 3. Solar photovoltaic conversions 4. Fuel cell and Hydrogen Energy			
Syllabus	Relevance of Renewable Energy in relation to depletion of fossil fuels, Environmental considerations, Green energy, centralized and decentralized energy Sun as a source of energy, Flat plate and evacuated tubular collectors, efficiency of collectors, overall heat loss coefficient and heat transfer correlations, Solar thermal applications like solar cooker and solar water heaters, solar dryers, solar stills, thermal energy storage, active and passive heating of buildings Fundamentals of photovoltaic Energy Conversion, Physics and Materials properties basic to photovoltaic conversion, Optical properties of solids, Direct and indirect transition semiconductors, interrelationship between absorption coeeficient and band gap, recombination of carriers, Types of solar cells, pn junction solar cells, transport equation, current density, brief description of single crystal silicon and amorphous silicon solar cells, e.g. tandem solar cells, solid liquid junction solar cells, Design of PV systems Hydrogen Energy, Solar Hydrogen through photoelectrolysis and photocatalytic process. Physics of material characteristics for production of solar hydrogen, Brief discussion of various storage processes, , new storage modes, Various factors relevant for safety, use of Hydrogen as fuel, use in vehicular transport, hydrogen for electricity generation, Fuel Cells			
Expected Outcome	The Student is expected to understand the importance of Energy for sustenance and development. They should be able to design sustainable energy solution for various end uses.			
Text Book	1. Twidel and Weir, Renewable Energy, E& F N Spon ltd. 2. Bhattacharya, T. Terrestrial Photovoltaics, Narosa			
Reference	1.Duffie and Beckman, Solar Engineering of thermal processes, John Wiley and Sons, New York 2. Godfrey Boyle, Renewable Energy: Power for a sustainable Future, Oxford.			
Faculty	Dr. Seemin Rubab	Contact	rubab@nitsri.ac.in	

<table>
<tr><td rowspan="2">PSPHY EL 02</td><td rowspan="2">Nanoscience & Nano-Materials</td><td>C</td><td>L</td><td>T</td><td>P</td></tr>
<tr><td>4</td><td>3</td><td>1</td><td>0</td></tr>
<tr><td>Course Objectives</td><td colspan="5">The course is an introduction to nanoscience and the aim is to introduce the student to the fundamentals of Nanomaterials and their technological applications in day to day life.
1. Basics of nanoscience & its emergence with multidisciplinary concept
2. Nanomaterials and fabrication by various techniques including the biological one
3. Properties at nanoscale and how they are better as compared with their bulk counterparts.
4. Technological applications in day to day life of Nanomaterials.</td></tr>
<tr><td>Syllabus</td><td colspan="5">The scientific revolutions – Nanoscience, Nature and scope, surface to volume ratio, quantum effects- classification of nanocrystals - dimensionality and size dependent phenomena; Quantum dots, Nanowires and Nanotubes 90,1,2 dimensions)

Preparations Methods, Top down and bottom up, Special nanomaterials - Carbon based nanomaterials, Graphene. Properties of materials & nanomaterials, Electronic Properties, Photoconductivity, Optical absorption & transmission, Photoluminescence, Fluorescence, Phosphorescence, Electroluminescence, Important properties in relation to nanomagnetism- Nanoscale magnetism – Transport in a magnetic field, Dielectric properties
Industrial applications of Nanomaterials: Nanomaterials in bone substitutes & Dentistry, Biochips- analytical devices, Biosensors, Materials in Medicines, Agriculture and engineering</td></tr>
<tr><td>Expected Outcome</td><td colspan="5">Students expected to apply above knowledge for advanced study and research in nanomaterial applications.
Skills: The candidate should be able to:
Have hands-on laboratory experience and should be able to operate all sophisticated equipments and fabrication techniques.</td></tr>
<tr><td>Text Book</td><td colspan="5">1. “Nanostructures & Nanomaterials: Synthesis, Properties &Applications” G. Cao, Imperial College Press, 2004.
2. Nanomaterials: An introduction to synthesis, properties and application, Dieter Vollath, WILE-VCH, 2008
3. Rao, C.N.R., Thomas, P. John, Kulkarni, G.U Nanocrystals, Synthesis, Properties and Applications, Springer 2007</td></tr>
<tr><td>Reference</td><td colspan="5">1. T Pardeep, Nano the essentials, Understanding the Nanoscience and Nanotechnology, Tata McGraw-Hill 2007
2. M S R Rao and S Singh, Nanotechnology and Nanotechnology, Wiley 2013,
3. Shah M A and Shah K A, Science of Small, Wiley 2019</td></tr>
<tr><td>Faculty</td><td>Dr. M A Shah</td><td colspan="2">Contact</td><td colspan="2">shahji@nitsri.ac.in</td></tr>
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<tr><td rowspan="2">PSPHY EL 03</td><td rowspan="2">Atmospheric & Environmental Physics</td><td>C</td><td>L</td><td>T</td><td>P</td></tr>
<tr><td>4</td><td>3</td><td>1</td><td>0</td></tr>
<tr><td>Course Objectives</td><td colspan="5">The students are made capable of assimilating functional areas of environment for formulating better conservation strategies in future.
1. Formation of ionized layers
2. Atmospheric structure
3. Transport of pollution
4. Biological invasion</td></tr>
<tr><td>Syllabus</td><td colspan="5">Introduction, source of ionization, formation of an ionized layer, The ionospheric regions, Distribution of ion in the topside ionosphere, Magnetic field variation and concepts of atmospheric dynamo and motor, Moments in the atmospheric plasma and neutral atmospheric interaction currents in ionosphere

Basics of the atmospheric structure. Electromagnetic radiation, absorption and emission. The radiation balance and the greenhouse gases. Energy balance at the earth's surface. Water balance. Hydrological cycle. The water movements in ground and soil. Transport of pollution in water and air.

Concept and scope of environmental Physics with respect to human environment; Energy use and efficiency in buildings. Energy losses, calculation of energy loss es, energy gains.Air regulation in buildings, heat pumps.Energy resources and the ir exploitationEnergy use pattern in different parts of the world and its impact on the environment. CO_2 emission in atmosphere.

Biological Invasion: concept; pathways, process, mechanism, impacts, examples of major invasive species in India, Earthquakes, distribution and mechanism. Seismic waves.Environmental applications in meteorology, hydrology and geophysics. Environmental Management.</td></tr>
<tr><td>Expected Outcome</td><td colspan="5">After the course the student shall
- understand how physics can be applied in the atmospheric & environmental sciences.
- have basic knowledge about meteorology, hydrology and geophysics.
Environmental Management enables candidates to have a broader view and knowledge of various facets of environmental management</td></tr>
<tr><td>Text Book</td><td colspan="5">1. M. Zeilik and E.V.P Smith:Introductory Astronmy and astrophysics.
2. John L Monteith and Mike H Unsworth, Principles of Environmental Physics, 4th Edition Elesiver, 2004.
3. Egbert Boeker and Rienk van Grondelle, Environmental Physics: Sustainable Energy and Climate Change, 3rd Edition wiley, 2011.</td></tr>
<tr><td>Reference</td><td colspan="5">1. Kali Forinash, Physics and the Environment, IOP Publishers 2017
2. Brewer, R. The Science of Ecology, Sanders College Publishing Co., Tokyo, 1994</td></tr>
<tr><td>Faculty</td><td>Dr. M A Shah</td><td colspan="2">Contact</td><td colspan="2">shahji@nitsri.ac.in</td></tr>
</table>

PSPHY EL04	**Semiconductor Device**	C	L	P	T
		4	3	1	0
Course Objective	To give knowledge about semiconductor physics and discus working and applications of different basic devices. 1. Remember the basic concept semiconductor physics. 2. Understand the working of homo/hterojunction and Hall Effect. 3. Explain MOS structure and study of I-V and C-V characteristic of MOS 4. Students are able to understand the working of Solar cell, LED, Photodetector.				
Syllabus	Classification of Semiconductors: Fermi-energy and carrier concentration, Carrier transport phenomenon: Carrier drift and diffusion, Carrier generation and recombination processes: direct recombination, Indirect recombination, Surface recombination, Auger recombination, Generation, and Carrier lifetime. PN junction: Energy band diagram, electrostatics of pn junction, pn junction current, ideal current-voltage relationship, junction breakdown mechanisms, heterojunctions and homojunction semiconductor, Hall Effect; Four-point probe resistivity measurement. Metal-semiconductor contacts: Schottky barrier diodes, current transport in Schotty diodes, I-V characteristics, Ohmic contacts. MOS structure: Ideal MOS structure, energy band diagrams under accumulation depletion and inversion conditions, C-V characteristics, various oxide charges in Si/SiO_2, MOS and their effect on C-V graph Optical devices: Radiative and non-radiative transitions, Light emitting Diode (LED), Photodiode, Phototransistor, Charge couples device (CCD), photodetector, Solar cell, introduction of sensors and working.				
Expected Outcome	1. Students will be get knowledge to explain the basic properties of semiconductors including the band gap, charge carrier concentration, doping and charge carrier injection/excitation. 2. Students will get ability to explain the working, design considerations and applications of various semiconducting devices. **Skills:** Students will be able to describe the working and design considerations for the various photonic devices like photodetectors, solar-cells and LEDs				
Text Book	1. Millman and Halkins; Electronic Devices and Circuits. 2. Ben G. Streetman; Solid State Electronic Devices. 3. Boylestad & Nasheisky; Electronics Devices and Circuit theory.				
Reference	1. S.M. Sze; Semiconductor Devices: Physics and Technology, 2nd edition, John Wiley, New York, 2002. 2. B.G. Streetman and S. Benerjee; Solid State Electronic Devices, 5th edition, Prentice Hall of India, NJ, 2000				
Faculty	Dr. M. Z. Ansari	Contact	mohdzubair@nitsri.ac.in		

<table>
<tr><td>PSPHY EL05</td><td colspan="2">Medical Physics</td><td>C: 4 | L: 3 | T: 1 | P: 0</td></tr>
<tr><td>Course Objectives</td><td colspan="3">The focus of the course provides a broad knowledge on the interaction of radiation with soft matter.
1. Basics of radiological physics,
2. interaction of radiation with matter,
3. Basic dosimetric concepts and radiation detectors
4. Principles of telecobalt, linear accelerator</td></tr>
<tr><td>Syllabus</td><td colspan="3">Cells, structure and functions, Radiation sources - Natural and artificial radioactive sources - Large scale production of isotopes - Different sources of Non Ionising radiation-their physical; properties-

Electrical Impedance and Biological Impedance - Principle and theory of thermography - applications – Basic principles of radiation detection - Counting systems for alpha and beta radiation -

Principles of Radiation detection – properties of dosimeters - Theory of gas filled detectors – Ion chamber dosimetry systems - free air ion chamber – parallel plate chamber - ionization chamber –

Laser Surgical Systems-Measurement of fluence from optical sources - Optical properties of tissues – theory and experimental techniques-interaction of laser radiation with tissues –microscopy in medicine - Interaction of light (electrons and positrons) and heavy charged particles with matter –Malignant Tumours, material response – deformation and failure – friction and wear</td></tr>
<tr><td>Expected Outcome</td><td colspan="3">After the course the student shall

- Students will be able to understand the interaction of radiation with matter with emphasis on energy transfer and dose deposition and will understand exponential attenuation under narrow and broad beam conditions, to better understand shielding design.

Skill: Should be able to deal with radiology and other related patients</td></tr>
<tr><td>Text Book</td><td colspan="3">1. S. S. Martellucci and A. N. Chester, Laser Photobiology and Photomedicine, Plenum Press, New York, 1985.
2. Markolf H. Neimz, Laser-Tissue Interactions, Springer Verlag, Germany, 1996.
3. Radiation oncology physics: A Handbook for teachers and students. IAEA publications 2005.</td></tr>
<tr><td>Reference</td><td colspan="3">1. F.M.Khan,The Physics of Radiation Therapy,Third Edition,Lippincott Williams and Wilkins,U.S.A.,2003.
2. Samantha Morris, Radiotherapy physics and equipment, Churchill Livingstone, 2001
3. Richad Aston, Principles of Biomedical Instrumentation and measurement, Merrill Publishing Co., London, 1990.</td></tr>
<tr><td>Faculty</td><td>Dr. M A Shah</td><td>Contact</td><td>shahji@nitsri.ac.in</td></tr>
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<table>
<tr><td>PSPHY EL06</td><td>Solar Photovoltaics</td><td>C
4</td><td>L
3</td><td>T
1</td><td>P
0</td></tr>
<tr><td>Course Objective</td><td colspan="5">The course focuses on technologies using the sun as energy resource. Using Sun Energy with help of photovoltaic effect convert into electricity.
1. To identify the electrical characteristics of solar cell and understand the working principle of solar cell.
2. To understand the physical principles of the photovoltaic solar cell and what are its sources of losses.
3. Classify the solar cell technologies such as Silicon, Thin film, Organic, DSSC. Design the solar cell and able to bring innovative ideas in the field of solar photovoltaic energy.</td></tr>
<tr><td>Syllabus</td><td colspan="5">Human and World energy consumption, Sustainable Sun Energy advantages and conversion challenges, Solar spectrum, A brief review of different types of solar cells in the market.

Photoelectric effect, Photoconductivity, Photo emissive effect and photovoltaic effect, A comparison, Working principle of solar cells, Generation of charge carriers, Separation and collection solar cell parameters, Equivalent circuit, External solar cell parameters, External quantum efficiency and Equivalent circuit.

The thermodynamic limit, Shockley-Quiesser limit, Losses in Solar cell design, Design for high Isc, High Voc, High FF. Analytical techniques, Solar simulator, Quantum efficiency measurement minority carrier life time and diffusion length measurement.

Silicon wafer based solar cell, basic silicon solar cell, Strategies to enhance Absorption, Reduce surface recombination, Reduce series resistance, Thin film solar cells, Transparent conducting oxides, Chalcogenide solar cells, Organic photovoltaics, Perovskite, Dye sensitized solar cells, Hybrid organic, Inorganic solar cells, Multi-junction solar cells, Spectral conversion, Multi exciton generation</td></tr>
<tr><td>Expected Outcome</td><td colspan="5">1. Students will gain an understanding of the available solar energy and the current solar energy conversion and utilization processes.
2. Students will able to comprehend the challenges in sustainable energy processes, perform cost analysis, design photovoltaic systems for different applications meeting residential and industrial needs, predict and test performance.

Skills: Students will gain an insight of the photovoltaic system engineering aspects including modeling and upscaling of the PV systems with different approaches, and be able to advance photovoltaic systems.</td></tr>
<tr><td>Text Book</td><td colspan="5">1. Chetan Singh Solanki, Solar Photovoltaics, Fundamentals, Technologies and applications, PHI Learning, 2011.
2. Klaus Jäger, Olindo Isabella, Arno H.M. Smets, René A.C.M.M. van Swaaij Miro Zeman, Solar Energy Fundamentals, Technology and Systems, Delft University of Technology (2014).</td></tr>
<tr><td>Reference</td><td colspan="5">1. Jenny Nelson, The Physics of Solar Cells, Imperial College Press (2013).
2. Matin A.Green, Solar cells Operating principles, technology and system applications, University of New South Wales (1992).</td></tr>
<tr><td>Faculty</td><td>Dr. M. Z. Ansari</td><td colspan="2">Contact</td><td colspan="2">mohdzubair@nitsri.ac.in</td></tr>
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<table>
<tr><td>PSPHY EL 07</td><td colspan="4">Advanced Condensed Matter Physics</td><td>C
4</td><td>L
3</td><td>T
1</td><td>P
0</td></tr>
<tr><td>Course Objectives</td><td colspan="8">The course aim is to understand the general aspects of the Advanced condensed matter physics.
1. Students will be able to understand the Surface and Interfaces of solids.
2. Students will be able to understand the Phase Transitions.
3. Students will be able to understand optical properties of Plasmons, Polaritons.
4. Students will be able to understand Characterization Techniques used for the Characterization of the Materials.</td></tr>
<tr><td>Syllabus</td><td colspan="8">Surface And Interfaces: Works Function and Contact Potential; Thermionic Emission; Low-Energy Electron Diffraction; Electronic Surface Levels; Super Lattices; Quantum Wells; Quantum Wires, Quantum Dots and Carbon Nanotubes, Numerical Problems.

Phase Transitions: Order Parameter; Critical Points; First and Second Order Phase Transitions; Mean Field Theory; Properties Near Critical Point; Landau Theory; Bragg-Williams Theory; Liquid-Gas Transition and Isotropic-Mematic Transition, Numerical Problems.

Plasmons, Polaritons: Dielectric Function; Transverse Optical Modes in Plasma, Application to Optical Phonon Modes in Ionic Crystals, Interaction of E.M. Waves with Optical Modes (Polaritons). LST Relation; Mott Metal-Insulator Transition; Electron-Electron Interaction; Numerical Problems.

Characterization Techniques: Scanning electron Microscopy, Atomic force microscopy: Different operational mode and typical applications. Thermal analysis techniques: DTA, DSC, TGA and STA. Two and four probe resistivity measurement methods, Dielectric measurement techniques, Magnetic measurement systems: Vibrating sample Magnetometer (VSM), Superconducting Quantum Interference Device, Numerical Problems.</td></tr>
<tr><td>Expected Outcome</td><td colspan="8">Upon successful completion of the course, student should be able to:
1. The General Aspects of Surface and Interfaces.
2. To Introduce the General Aspects of Phase Transitions.
3. To Introduce The General Aspects of Plasmons, Polaritons.</td></tr>
<tr><td>Text Book</td><td colspan="8">1. Harrison P, “Quantum Wells, Wires and Dots”, Wiley & Sons Ltd.
2. Chaikin P M and Lubensky T C, “Principles of Condensed Matter Physics”, CambridgeUniversity Press.
3. Kittel, C., Introduction to Solid State physics, 8th edition, (Wiley Eastern Ltd.)</td></tr>
<tr><td>Reference</td><td colspan="8">1. Principles of the theory of solids: J.M Ziman.
2. Solid State Physics: A. J. Dekker, Macmillan, New Ed.
3. A.D. Helfrick and W.D.Cooper: Modern Electron Instrunmentation and Measurement techniques</td></tr>
<tr><td>Faculty</td><td>Prof. M. Ikram</td><td>Contact</td><td colspan="6">ikram@nitsri.ac.in</td></tr>
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P.G Department of Physics, NIT Srinagar (J&K)

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<tr><td rowspan="2">PSPHY EL 08</td><td rowspan="2">Quantum Field Theory</td><td>C</td><td>L</td><td>T</td><td>P</td></tr>
<tr><td>4</td><td>3</td><td>1</td><td>0</td></tr>
<tr><td>Course Objectives</td><td colspan="5">This course provides an introduction to quantum field theory as one of the cornerstones of modern physics, and how it inevitably emerges from combining quantum mechanics with special relativity. The course is aimed:
1. To introduce the basic ideas of quantum field theory;
2. To understand how quantum mechanics and special relativity combine to produce realistic theories of particle creation and annihilation;
3. To develop calculational techniques to at least the level of tree-level Feynman diagrams for quantum electrodynamics;
4. To provide the foundation for more advanced studies in quantum field theory.</td></tr>
<tr><td>Syllabus</td><td colspan="5">Klein Gordon, Dirac, Weyl and Majorana Eqns. Plane wave Solutions and observation. Non- relativistic limits of Dirac Eqn. Foly Wouthyer transformation. Canonical quantization of neutral scalar, Charged scalar, spin 1/2 and massive spin-i fields, Pock space and observables. Field commutation, anticommutation relations.

Interaction picture. Normal product. Wick’s theorem. Feynman propagator S-matrix. Feynman diagrams for itheory. Quantization of electromagnetic field. Gupta-Bleuler condition. Indefinite metric.

Feynman diagrams of QED. Tree level calculations of Moll Bhabha, Compton and Scattering in external field. General Formulation. Conjugate Momentum and Quantization. Neutral Scalar Field. Commutation Relations, Normal Ordering, Bose Symmetry, Fock Space.

The Dirac Equation, Relativistic Covariance. Anti-Commutators. Quantization of the Dirac Field, Electrons and Positrons. Connection between Spin and Statistics. Discrete Symmetries, Parity, Charge Conjugation, Time Reversal, CPT Theorem. Gauge Invariance and Gauge Fixing. Quantization of the Electromagnetic Field, Propagator, Vacuum Fluctuations</td></tr>
<tr><td>Expected Outcome</td><td colspan="5">On completion of this course, the student will be able to:
1. Quantize classical fields and will know how to describe both fermionic and bosonic particles in relativistic quantum mechanics.
2. Derive the Feynman rules for a given theory, and how to use those to calculate cross sections and decay rates at lowest order in perturbation theory.
3. Explain how gauge symmetries lead to the construction of both Abelian and non-Abelian theories and understand the concept of spontaneously breaking these symmetries (Higgs mechanism).
4. Understand the structure of the standard model of particle physics and can relate its ingredients to the underlying fundamental principles.
Skills: Present the fundamental principles of quantum field theory, and solutions to typical problems, in a clear and pedagogic way to fellow student</td></tr>
<tr><td>Text Book</td><td colspan="5">1. Bogolinbov & Shirkov : Introduction to Quantized Field Theory
2. Bjorken & Drell : Quantum Field Theory
3. Quantum Field Theory, L. H. Ryder, Cambridge University Press (2008)</td></tr>
<tr><td>Reference</td><td colspan="5">1. Quantum Field Theory, C. Itzykson and J. B. Zuber, McGraw-Hill Book Co (1985).
2. Quantum Field Theory, L. H. Ryder, Cambridge University Press (2008).</td></tr>
<tr><td>Faculty</td><td>Dr. P. A. Ganai</td><td colspan="2">Contact</td><td colspan="2">princeganai@nitsri.ac.in</td></tr>
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<tr><td rowspan="2">PSPHY EL 09</td><td colspan="2" rowspan="2">Relativity and Cosmology</td><td>C</td><td>L</td><td>T</td><td>P</td></tr>
<tr><td>4</td><td>3</td><td>1</td><td>0</td></tr>
<tr><td>Course Objectives</td><td colspan="6">This course is an introduction to Einstein's theory of general relativity, and includes applications to early universe cosmology and the inflationary paradigm. The course is aimed to make student familiar with
1. Basic concepts of special and general relativity.
2. Provide some skill in their use.
3. Promote skill in clear, precise, and analytical thinking and to provide practice in altering one's opinions and intuitive picture of a structure in light of new evidence.
4. Important cosmological observations and how they are used to determine the characteristics of the Universe.</td></tr>
<tr><td>Syllabus</td><td colspan="6">Review of special theory of relativity and tensor calculus, Applications of general relativity:
Schwarzschild's exterior solution, singularity, event horizon and black holes, isotropic coordinates, Birkhoff's theorem, Observational tests of Einstein's theory.

Gravitational Collapse and Black Holes (Qualitative).White Dwarfs, Neutron stars and Black Holes, Static Black Holes (Schwarzschild and Reissner-Nordstrom). Rotating Black Holes, Kerr Metric (derivation not required), Event Horizon, and Extraction of energy by Penrose process, Kerr- Neumann Metric (no derivation). No hair theorem, Cosmic Censorship Hypothesis.

Cosmology, Principles, Weyl postulates, Robertson-Walker metric (derivation is not required), Cosmological parameters, Static Universe, Expanding universe, Open and Closed universe, Cosmological red shift, Hubble's law. Olber's Paradox.

Qualitative discussions on: Big Bang, Early Universe (thermal history and nucleosynthesis), Cosmic Microwave Background Radiation, Event Horizon, Particle Horizon and some problems of Standard Cosmology</td></tr>
<tr><td>Expected Outcome</td><td colspan="6">On completion of this course, the student will be able to:
1. Gain an appreciation for the main principles of special and general relativity and how the latter provides the natural language to describe the evolution of the early universe..
2. Describe how quantum fluctuations during inflation are the source of density fluctuations and gravitational waves.
Skills: The students should learn basic analytical skills needed to solve Einstein's equations them (for example, finding simple blackhole solutions).</td></tr>
<tr><td>Text Book</td><td colspan="6">1. J. V. Narlikar- General Relativity and Cosmology (MacMillion, 1978).
2. J. V. Narlikar –Introduction to Cosmology (Cambridge Univ, Press, 1993).
3. A. K. Roychaudhuri, S. Banerjee and A. banerjee- General Relativity, Astrophysics and Cosmology (Springer-Verlag, 1992).</td></tr>
<tr><td>Reference</td><td colspan="6">1. S. Weinberg- Gravitation and Cosmology: Principles and Applications of the General Theory of Relativity (Wiley, 1972).
2. P. G. Bergmann- Introduction to Theory of Relativity (Prentice-Hall, 1969).
3. W.G.V.Rosser – Introduction to the Theory of Relativity.</td></tr>
<tr><td>Faculty</td><td>Dr. P. A. Ganai</td><td>Contact</td><td colspan="4">princeganai@nitsri.ac.in</td></tr>
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<table>
<tr><td>PSPHY EL 10</td><td colspan="3">Materials Science</td><td>C: 4 | L: 3 | T: 1 | P: 0</td></tr>
<tr><td>Course Objectives</td><td colspan="4">The main objective of this course is to familiarize students with a range of materials that are used in various applications
1. To provide strong foundation in materials.
2. To introduce different synthesis method for the materials.
3. To develop a strong understanding in different crystal structure.
4. Microstructure characterization by direct & indirect methods.</td></tr>
<tr><td>Syllabus</td><td colspan="4">Classification of materials: Crystalline & amorphous materials, high Tc superconductors, alloys & composites, semiconductors, solar energy materials, luminescent and optoelectronic materials, Polymer, Liquid crystals and quasi crystals, Ceramics. Composites

Preparation of materials by different techniques: Single crystal growth, zone refining, epitaxial growth. Melt-spinning and quenching methods, sol-gel, polymer processing. Preparation of ceramic materials; Fabrication, control and growth modes of organic and inorganic thin films: different technique of thin film preparations: Basic principles, Point defect, line defect, plane defect, volume defect, dislocation, stacking faults, application, and Burger vectors.

Structure of metals, semiconductors and ceramics: Difference between structures of metals and ceramics, close-packed structures: BCC, FCC & HCP metals. Structure of semiconductors: Si, Ge, ZnS, pyrites, chalcopyrite's, ZnO etc.; structure of ceramics: metal oxides, nitrides, carbides, borides, ferrites, perovskites, etc.

Microstructure characterization by direct & indirect methods: Diffraction techniques: interpretation of x-ray powder diffraction patterns, Identification & quantitative estimation of unknown samples by X-ray powder diffraction technique and fluorescent analysis. Theory and method of particle size analysis. Integral breadth method, Warren-Averbach's Fourier method, profile fitting method, Rietveld Method.</td></tr>
<tr><td>Expected Outcome</td><td colspan="4">The student have the strong understanding of the classification of materials and uses of the materials in different applications.
Student will be able to differentiate BCC and FCC crystal structure.
Skills: Student will be able to develop new materials and characterize them and use them effectively</td></tr>
<tr><td>Text Book</td><td colspan="4">1. Materials science and Engineering by V. Raghavan, Prentice-Hall Pvt. Ltd.
2. Thin Solid Films by K. L Chopra.
3. Engineering Materials by Kenneth G. Budinski.</td></tr>
<tr><td>Reference</td><td colspan="4">1. Elements of X-ray diffraction by B. D. Cullity, Addison-Wesley Publishing Co.
2. Elements of crystallography by M. A. Azaroff.</td></tr>
<tr><td>Faculty</td><td>Dr. Vijay Kumar</td><td>Contact</td><td colspan="2">vijay@nitsri.ac.in</td></tr>
</table>

Fourth Semester

SEMESTER – IV

S. No.	Course Code	Courses	L	T	P	Credits
1	PSPHY PR01	Research Methodology/One optional	2	0	0	4
2	PSPHY PR02	Project/Dissertation and Viva voce	0	0	50	36
	Total					**100**

<table>
<tr><td>PSPHY PR01</td><td>Research Methodology</td><td>C
4</td><td>L
3</td><td>T
1</td><td>P
0</td></tr>
<tr><td>Course Objectives</td><td colspan="5">The main objectives of the course are:
1. To familiarize the students with basic concepts of research and its process.
2. To identify and discuss the concepts and procedures of sampling, data collection and analysis.
3. To impart knowledge for enabling students to develop data analysis and interpretation skills in order to solve the research problem
4. To demonstrate enhanced writing skills</td></tr>
<tr><td>Syllabus</td><td colspan="5">Syllabus
Research Methodology
Meaning of research, Objectives of research, Types of research, Research approaches, Significances of research, Research methods versus methodology, Research and scientific methods, Research processes, Criteria for good research, Research problem, Selecting the problem, Necessity of defining the problem,
Research Design and sample Surveys
Meaning and need for research design, features of a good design. Important concepts relating to research design: Dependent and independent variables, Extraneous variables, Control, Research hypothesis, Experimental and non-experimental hypothesis – Testing research, Experimental and control group, Different research designs: Research design in case of exploratory research studies, Research design in case of hypothesis- testing research studies.
Data Collection and Data Preparation
Experiments and surveys, Collection of primary data: Difference between questionnaire and schedule, Guidelines for constructing questionnaire/schedule, Collection of secondary data, Selection of appropriate methods for data collection, Case study method. Data preparation process: Questionnaire checking, Editing, Coding, Classification, Tabulation, Graphical representation, Data cleaning, Data adjustment, Types of analysis, Statistics in research.
Interpretation and Report Writing
Meaning of Interpretation, Technique of Interpretation, Precautions in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of Research Report, Types of Reports, oral Presentation, Mechanics of Writing Research Report, Precautions for writing Research reports.</td></tr>
<tr><td>Expected Outcome</td><td colspan="5">The student should be well versed to take a research problem for his/her master's or doctoral research. They should understand the nuances of scientific writing and IPR.</td></tr>
<tr><td>Text Book</td><td colspan="5">1. The Craft of Scientific Writing (3rd Edition), Michael Alley, Springer, New York, 1996.
2. Science and Technical Writing – A Manual of Style (2nd Edition), Philip Reubens (General editor), Routledge, New York, 2001.</td></tr>
<tr><td>Reference</td><td colspan="5">1. Writing Remedies – Practical Exercises for Technical Writing Edmond H. Weiss, Universities
Press (India) Ltd., Hyderabad, 2000.
2. Effective Technical Communication, M. Ashraf Rizvi, Tata Mc Graw – Hill, New Delhi, 2005.</td></tr>
<tr><td>Faculty</td><td>Dr. S Rubab</td><td colspan="2">Contact</td><td colspan="2">rubab@nitsri.ac.in</td></tr>
</table>

Research Based Project

PSPHY PR02	Project	C	L	T	P
		36	0	0	0

Guidelines for Project in M.Sc. Course:

1. Projects would be allotted to M.Sc. (Previous) students which have to be carried out and completed in M.Sc. (Final)..
2. A list of projects will be finalized and announced by the Department. The students will have an option to select the project in their field of interest.
3. The project will comprise of the following:
    a. Study of background material identity period of a given crystal using Rotation method.
    b. Collection of data, procurement and fabrication of experimental Set up and writing of computer programs if needed.
    c. Giving a preliminary seminar before the final presentation for the purpose of internal assessment whose weight age would be 25%.
    d. Writing a dissertation or project report. This will be submitted by the M.Sc. (Final) students in the first week of March.
4. The Final evaluation of the project work completed will be done by external and internal examiners appointed by the Board of Studies on the basis of an oral presentation and the submitted Project-Report.
5. The weight age of the final evaluation would be 75%.

LET'S ALL WORK TOGETHER TO MAKE THE PHYSICS DEPARTMENT AT NIT SRINAGAR A WELCOMING ENVIRONMENT.