Name of The Faculty: Faculty of Science

Name of the Program : M. Sc. (Physics)

Scheme of Study/ Scheme of Examination, 2020 Onwards

Sr. No.	Semester/ Year	Course Code	Course Name	Theory/ Practical	Core/ AECC/ SEC/ DSE/ GE/OE	Lecture	Tutorial	Practical	Credits	Theory							Practical										Overall Maximum Marks	Overall Pass Marks	Whether to be offered under CBCS (Yes/No)	Scheme of Examinations (Theory+Internal +Practical+Oral/ Theory+Internal +Practical/ Theory+Practical)
										Summative Assess		Formative Assessment					Summative Assessment				Formative Assessment									
										Max	Pass	Sessional/Class Test	Assignment	Professional Activities	Max	Pass	Demonstration/Conduct/Presentation	Viva-voce	Max	Pass	Attendance & Regularity in Lab Work	Project/Laboratory Work Report	Midterm Oral Examination/Assessment	Conduct/Demonstration	Max	Pass				
1		17080101	Mathematical Physics	Theory	Core	3	0	0	3	60	24	20	10	10	40	16											100	40	NO	Theory+Internal
2		17080102	Mathematical Physics Lab	Practical	Core	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40	NO	Practical+Internal
3		17080103	Classical Mechanics	Theory	Core	3	0	0	3	60	24	20	10	10	40	16											100	40	NO	Theory+Internal
4		17080104	Classical Mechanics lab	Practical	Core	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40	NO	Practical+Internal
5	I / I	17080105	Statistical Mechanics	Theory	Core	3	0	0	3	60	24	20	10	10	40	16											100	40	NO	Theory+Internal
6		17080106	Statistical Mechanics Lab	Practical	Core	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40	NO	Practical+Internal
7		17080107	Professional Ethics & Human Values	Theory	AECC	2	0	0	2	60	24	20	10	10	40	16											100	40	NO	Theory+Internal
8		17080108	Computational Methods & Programming(Matlab/Python)	Theory	SEC	2	0	0	2	60	24	20	10	10	40	16											100	40	NO	Practical+Internal
9		17080201	Quantum Mechanics	Theory	Core	3	0	0	3	60	24	20	10	10	40	16											100	40	NO	Theory+Internal
10		17080202	Quantum Mechanics Lab	Practical	Core	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40	NO	Practical+Internal
11		17080203	Electrodynamics and Plasma Physics	Theory	Core	3	0	0	3	60	24	20	10	10	40	16											100	40	NO	Theory+Internal
12	II/I	17080204	Electrodynamics and Plasma Physics Lab	Practical	Core	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40	NO	Practical+Internal
13		17080205	Atomic and Molecular Physics	Theory	Core	3	0	0	3	60	24	20	10	10	40	16											100	40	NO	Theory+Internal
14		17080206	Atomic and Molecular Physics Lab	Practical	Core	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40	NO	Practical+Internal
15		17080207	Research Methodology	Theory	AECC	2	0	0	2	60	24	20	10	10	40	16											100	40	NO	Theory+Internal
16		17080208	The Physics of Nano Materials	Theory	SEC	2	0	0	2	60	24	20	10	10	40	16											100	40	NO	Practical+Internal
17		17080301	Laser and its applications	Theory	SEC	2	0	0	2	60	24	20	10	10	40	16											100	40	NO	Theory+Internal
18			Open Elective Course	Theory	OEC	3	0	0	3	60	24	20	10	10	40	16											100	40	NO	Theory+Internal
19		17080303	Semiconductor Devices	Theory	DSEC	3	0	0	3	60	24	20	10	10	40	16											100	40	NO	Theory+Internal
20		17080304	Semiconductor Devices Lab	Practical	DSEC	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40	NO	Practical+Internal
21		17080305	Digital Electronics	Theory	DSEC	3	0	0	3	60	24	20	10	10	40	16											100	40	NO	Theory+Internal
22		17080306	Digital Electronics Lab	Practical	DSEC	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40	NO	Practical+Internal
23		17080307	Analog and Digital Communication	Theory	DSEC	3	0	0	3	60	24	20	10	10	40	16											100	40	NO	Theory+Internal
24		17080308	Analog and Digital Communication Lab	Practical	DSEC	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40	NO	Practical+Internal
25		17080309	Basic Concepts in Condensed Matter Physics	Theory	DSEC	3	0	0	3	60	24	20	10	10	40	16											100	40	NO	Theory+Internal
26		17080310	Basic Concepts in Condensed Matter Physics Lab	Practical	DSEC	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40	NO	Practical+Internal
27	III/II	17080311	Condensed Matter Physics: Physical Properties	Theory	DSEC	3	0	0	3	60	24	20	10	10	40	16											100	40	NO	Theory+Internal
28		17080312	Condensed Matter Physics: Physical Properties Lab	Practical	DSEC	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40	NO	Practical+Internal
29		17080313	Advanced Condensed Matter Physics	Theory	DSEC	3	0	0	3	60	24	20	10	10	40	16											100	40	NO	Theory+Internal
30		17080314	Advanced Condensed Matter Physics Lab	Practical	DSEC	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40	NO	Practical+Internal
31		17080315	Nuclear Physics	Theory	DSEC	3	0	0	3	60	24	20	10	10	40	16											100	40	NO	Theory+Internal
32		17080316	Nuclear Physics Lab	Practical	DSEC	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40	NO	Practical+Internal
33		17080317	Advanced Nuclear Physics : Structure and Reactions	Theory	DSEC	3	0	0	3	60	24	20	10	10	40	16											100	40	NO	Theory+Internal
34		17080318	Advanced Nuclear Physics : Structure and Reactions Lab	Practical	DSEC	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40	NO	Practical+Internal
35		17080319	Experimental techniques in Nuclear Physics	Theory	DSEC	3	0	0	3	60	24	20	10	10	40	16											100	40	NO	Theory+Internal
36		17080320	Experimental techniques in Nuclear Physics Lab	Practical	DSEC	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40	NO	Practical+Internal
		17080321	Summer Training	Practical					4								40	40	80	32	20	20	20	60	120	48	200	80	NO	Practical+Internal
37		17080401	Project Work	Practical	RT				20								80	80	160	64	40	40	40	120	240	96	400	160	NO	Practical+Internal
38		17080402	Electronics	Theory	DSEC	4	0	0	4	60	24	20	10	10	40	16											100	40	NO	Theory+Internal
39		17080403	Electronics- lab	Practical	DSEC	0	0	2	1								20	20	40	16	10	10	10	30	60	24	100	40	NO	Practical+Internal

40		17080404	Condensed Matter Physics: Basics	Theory	DSEC	4	0	0	4	60	24	20	10	10	40	16											100	40	NO	Theory+Internal
41		17080405	Condensed Matter Physics: Basics-Lab	Practical	DSEC	0	0	2	1								20	20	40	16	**10**	**10**	**10**	**30**	**60**	**24**	100	40	NO	Practical+Internal
42	IV/II	17080406	Introductory Nuclear Physics	Theory	DSEC	4	0	0	4	60	24	20	10	10	40	16											100	40	NO	Theory+Internal
43		17080407	Introductory Nuclear Physics-Lab	Practical	DSEC	0	0	2	1								20	20	40	16	**10**	**10**	**10**	**30**	**60**	**24**	100	40	NO	Practical+Internal
44		17080408	Advance Applied Physics	Theory	DSEC	4	0	0	4	60	24	20	10	10	40	16											100	40	NO	Theory+Internal
45		17080409	Advance Applied Physics-Lab	Practical	DSEC	0	0	2	1								20	20	40	16	**10**	**10**	**10**	**30**	**60**	**24**	100	40	NO	Practical+Internal
46		17080410	Spectroscopic Techniques	Theory	DSEC	4	0	0	4	60	24	20	10	10	40	16											100	40	NO	Theory+Internal
47		17080411	Spectroscopic Techniques-Lab	Practical	DSEC	0	0	2	1								20	20	40	16	**10**	**10**	**10**	**30**	**60**	**24**	100	40	NO	Practical+Internal
48			**Online Courses during 1st, 2nd, and 3rd semesters***						**9**																					

*** 4 week course-1 credit, 8 week course-2 credit, 12 week course-3 credit,**
Every semester a student may opt for either
one, 12 week course
one, 4 week course & one, 8 week course
Three, 4 week courses

Department of Physics
M.Sc. Physics
Syllabus and Curriculum (2020 onwards)
Program Structure under Choice Based Credit System (CBCS)

Semester-I

1. Name of the Department: **Physics**

2. Course Name	**Mathematical Physics**	**L**	**T**		**P**	
3. Course Code	17080101	3	0		0	
4. Type of Course (use tick mark)		**Core (√)**	**DSE ()**		**SEC ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical

Lectures = 40	**Tutorials** = 0	**Practical** = 0

8. Course Description:

The course will teach about a variety of mathematical methods which are used in solving problems in physics. These methods include solution of differential equations, tensors and matrices, and complex variables.

9. Course Objectives:

To impart knowledge about various mathematical tools employed to study physics problems.

10. Course Outcomes (COs):

Students will have understanding of
1. Various techniques to solve differential equations.
2. How to use special functions in various physics problems.
3. Use complex analysis in solving physical problems.
4. Use the orthogonal polynomials and other special functions;
5. Use Fourier series and integral transformation.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Vector spaces, tensors and matrices**

Vector spaces: Introduction, definition of linear vector space, Linear independence, basis and dimension, scalar product, orthonormal basis, Linear operators, Matrices, orthogonal, Unitary and Hermitian Matrices, eigen

values & Eigen vectors.		
Unit - 2	**Number of lectures = 10**	**Title of the unit: Differential equations and special functions**
First order equation, second order equation with variable coefficients, Ordinary point, singular point, series solution around an ordinary point and regular singular point, Solution of Legendre equation, Solution of Bessel's equation, Hermite & Laguerre equations.		
Unit - 3	**Number of lectures = 10**	**Title of the unit: Complex variables**
Function of complex variable, limit, continuity and differentiability of function of complex variables, Analytic function, Cauchy-Riemann conditions, Cauchy's integral theorem, Cauchy's integral formula, Taylor's and Laurent's series, singular points, residues, evaluation of residues, Cauchy's residue theorem, Jordan's lemma, evaluation of real definite integrals.		
Unit - 4	**Number of lectures = 10**	**Title of the unit: Integral transforms**
Fourier series, Dirichlet's conditions, Fourier series of arbitrary period, Half-wave expansions, development of the Fourier integral, Fourier integral theorem, Fourier transforms, Properties of Fourier transform.		
12. Brief Description of self-learning / E-learning component		
http://nptel.ac.in/courses/115103036/ http://web.mit.edu/al24406/www/mathmeth/DiffForms_SchulzSchulz_10Sep.pdf https://www.youtube.com/watch?v=LYNOGk3ZjFM		
13. Books Recommended		
1. G. Arfken and H.J. Weber. Mathematical Methods for Physicists. San Diego: Academic Press. ISBN-10: 0123846544. 2. A.W. Joshi. Matrices and Tensors in Physics. New Delhi: Wiley Eastern. ISBN-10: 8122405630. 3. P.K. Chatopadhyay. Mathematical Physics. New Delhi: Wiley Eastern. ISBN-10: 8122434401. 4. C. Harper. Introduction to Mathematical Physics. New Delhi: Prentice Hall of India. ISBN-10: 8120302621. 5. M.L. Boas. Mathematical Methods in the Physical Sciences. New York: John Wiley. ISBN-10 : 9780471198260 6. L. Pipes and L.R. Horwell. Applied Mathematics for Engineers and Physicists. ISBN-10 : 0486779513. 7. B.S. Rajput. Mathematical Physics. ASIN : B07YCGC4ZS 8. A. K. Ghatak and I. C. Goyal. Mathematical Methods for Physicists. ASIN : B07XDZVYC5		

<table>
<tr><td colspan="6">1. Name of the Department: Physics</td></tr>
<tr><td>2. Course Name</td><td>Mathematical Physics Lab</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td>17080102</td><td>0</td><td colspan="2">0</td><td colspan="2">4</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core (√)</td><td colspan="2">DSE ()</td><td colspan="2">SEC ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td></td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (√)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical</td></tr>
<tr><td colspan="2">Lectures =</td><td colspan="2">Tutorials = 0</td><td colspan="3">Practical = 52</td></tr>
</table>

8. Course Description:

This course will teach you the practical knowledge of how to obtain solutions to system of linear equations, differential equations, FFT etc. using computational methods.

9. Course Objectives:

This lab introduces students to numerical techniques used for solving mathematical problems that cannot be solved or are difficult to solve analytically.

10. Course Outcomes (COs):

Students will have understanding of:

1. MATLAB/Python basics

2. Various computational methods like matrix manipulation useful to solve research problems.

11. List of Experiments

1. Scalar and Vector Product in MATLAB/Python.
2. Eigenvalue and eigenvectors of various matrices in MATLAB/Python.

2. Solving systems of linear equations in MATLAB/Python.

3. Solving second order differential equation with variable coefficients in MATLAB/Python.

4. Solution of Legendre equation, in MATLAB/Python.

5. Numerically solving Bessel function of second kind in MATLAB/Python.

6. Evaluates the Laguerre polynomial, the generalized Laguerre polynomial, and the Laguerre function in MATLAB/Python.

7. Compute and plot a simple sinusoid of amplitude 1 and frequency f=1 for for $0<t<1$in MATLAB/Python.

8. Compute and plot a complex sinusoidal function consisting of the sum of 5 sine waves with equal amplitudes but whose frequencies are 1,3,5,10, and 20, again for t varying from 0 to 2π in MATLAB/Python.

9. Computing Fourier Series and Power Spectrum with MATLAB/Python.

10. Generating various waveforms using arbitrary function generator and using Tektronix Digital Phosphor Oscilloscope and finding its FFT.

Note: The list of the experiment given above should be considered as suggestive of the standard and available equipment. The faculty members are authorised to add or delete from this list whenever considered necessary.

12. Book Recommended:

1. Introduction to MATLAB 7 by ETTER, PEARSON INDIA. ISBN 9788131723135

2. Computational Physics, 2nd edition, Nicholas J. Giordano, Purdue University, Hisao Nakanishi, Purdue University Pearson Education Inc, 2006, ISBN: 978-0131469907.

3. Numerical Methods Kindle Edition by Babu Ram (Author) ASIN: B00G4YDRSS

4. https://www.mccormick.northwestern.edu/documents/students/undergraduate/introduction-to-matlab.pdf

5. https://in.mathworks.com/

6. A.W. Joshi. Matrices and Tensors in Physics. New Delhi: Wiley Eastern.

7. P.K. Chattopadhyay. Mathematical Physics. New Delhi: Wiley Eastern.

1. Name of the Department: Physics

2. Course Name	**Classical Mechanics**	**L**	**T**	**P**
3. Course Code	17080103	3	0	0
4. Type of Course (use tick mark)		**Core (√)**	**DSE()**	**SEC()**

5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical

Lectures = 40	**Tutorials = 0**	**Practical = 0**

8. Brief Syllabus:

The syllabus is divided into four units i.e. Lagrangian formulation and Hamilton's principle, rigid body motion, small oscillation and Hamilton equation, and canonical transformation and Hamilton-Jocobi theory.

9. Learning objectives:

The course aims to provide students with an understanding of the basics of Lagrangian formulation, Hamilton's principle and canonical transformation and Hamilton-Jacobi Theory. It also gives the idea how to write Lagrangian and Hamiltonian for the rigid body motion.

10. Course Outcomes (COs):

After the successful completion of the course, students would be able to

1. Apply the basics involved in the small oscillation and related Hamilton equation and experimental physics as rigid body dynamics with transformation
2. Apply their theoretical, experimental knowledge and conceptualizing their solutions
3. Use classical mechanics' scientific potential to analyze scientific ideas and explanations.
4. Demonstrations and learning of research-based knowledge of different system dynamics, mechanics based practical and project.

11. Unit wise detailed content

Unit-1	**Number of lectures = 12**	**Title of the unit: Lagrangian Formulation & Hamilton's Principle**

Mechanics of a system of particles, constraints of motion, generalized coordinates, D'Alembert's Principle Lagrange's velocity dependent forces (gyroscopic), dissipation function, Application of Lagrangian formulation Hamilton principle, Lagrange's equation from Hamilton principle, extension to non-holonomic systems.

Unit – 2	**Number of lectures = 10**	**Title of the unit: Rigid Body Motion**

Reduction to equivalent one body problem, the equation of motion and first integrals, the equivalent one-dimensional problem, the differential equation for orbits, Kepler's problem (inverse square law), The Euler's angles, rate of change of a vector, Coriolis force.

Unit – 3	**Number of lectures = 10**	**Title of the unit: Small Oscillations & Hamilton Equation**

Euler equation of motion, Torque free motion of rigid body, Eigen value equation, Free vibrations, Normal coordinates, Legendre Transformation, Hamilton’s equations of motion, Hamilton’s equations from variation principle, Principle of least action.		
Unit – 4	**Number of lectures = 8**	**Title of the unit: Canonical Transformation and Hamilton-Jacobi Theory**
Canonical transformation and its examples, Equation of motion, Poisson’s Brackets relations, Conservation Theorems., Hamilton-Jacobi equation Hamilton’s principal function, Harmonic Oscillator problem		
Brief Description of self-learning / E-learning component:		
To understand basic concepts in detail, students may get study materials on following links. https://onlinecourses.nptel.ac.in/noc18_ph02 http://www.damtp.cam.ac.uk/user/tong/dynamics/clas.pdf http://courses.physics.ucsd.edu/2010/Fall/physics200a/LECTURES/200_COURSE.pdf		

12. Books Recommended

1. Herbert Goldstein, **Classical Mechanics** Pearson Education; 3 edition (2011) (ISBN: 978-8131758915).
2. J.C. Upadhyaya, Classical Mechanics: Himalaya Publishing House, 2014 (ISBN: 978-9351427988)
3. N.C. Rana and P.S. Joag. Classical Mechanics. Tata McGraw-Hill, 2001, (ISBN: 978-0074603154)
4. Kiran C. Gupta. Classical Mechanics of Particles and Rigid Bodies. New Delhi: Wiley Eastern, 2018 (ISBN: 978-9386649782)

1. Name of the Department: Physics						
2. **Course Name**	**Classical Mechanics-Lab**	**L**	**T**		**P**	
3.Course Code	17080104	0	0		4	
4. Type of Course (use tick mark)		Core (√)	**DSE ()**		**SEC ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 0		**Tutorials = 0**	**Practical = 52**			
8. Course Description:						
In this course student will gain the practical knowledge about the Understand laws of motion and their application to various dynamical situations, computer Simulation of projectile motion and orbital mechanics, hyperbolic orbit motion with conic section, Hamilton's Least Action principle for a particle under the action of gravity, Action field of the Kepler/Coulomb problem						
9. Course Objectives:						
1. Understand laws of motion and their application to various dynamical situations. 2. Understand and study of Kepler's laws to describe the motion of planets and satellite in circular orbit. 3. Explain the phenomenon of simple harmonic motion. 4. Study of Hamilton's Least Action principle for a particle under the action of gravity						
10. Course Outcomes (COs):						
After successful completion of this course, students will be able to 1.Visualize the simulation, and correlate the theoretical concepts and identify its practical applications through experiments. 2. Understand laws of motion and their application to various dynamical situations 3. Understand and study of Kepler's laws to describe the motion of planets and satellite in circular orbit 4. Explain the phenomenon of simple harmonic motion 5. Study of Hamilton's Least Action principle for a particle under the action of gravity						
11. List of Experiments						
1. Simulation of projectile motion and orbital mechanics using both the Classical 4th Order Runge-Kutta method and Euler's Method (Simulation and Computational) 2. Conic section projectile hyperbolic orbit motion (Simulation and Computational) 3. Conic section curves with r min and r max (Simulation and Computational) 4. Hamilton's Least Action principle for a particle under the action of gravity (Computational and Simulation) 5. Attractive Potential, energy, curves for a body under a central force (Computational) 6. Orbit period to obtain the time it takes to go from r min to r max in an orbit due to a force of						

the form arp (Simulation and Computational)

7. Action field of the Kepler/Coulomb problem (Simulation and Computational)
8. Keplerian orbits and principle (Simulation and Computational)
9. Roll pendulum (Simulation and Computational)
   (The suspension point $K_1$of a plane pendulum slides frictionless along the x-axis. The pendulum body K_2 has the distance L from the suspension point. Both bodies have the same mass m_1=m_2=m and the connection between K_1 and K_2 is mass less)
10. To determine the height of a building using a Sextant.
11. To determine g and velocity for a freely falling body using Digital Timing Technique.
12. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
13. To determine the Young's Modulus of a Wire by Optical Lever Method.

Note: The list of the experiment given above should be considered as suggestive of the standard and available equipment. The faculty members are authorised to add or delete from this list whenever considered necessary.

12. Book Recommended

References for Laboratory Work:

1.Advanced Practical Physics for students, B. L. Flint and H. T. Worsnop, 1971, Asia Publishing House, ISBN-13 : 978-0423738902

2.Engineering Practical Physics, S. Panigrahi & B. Mallick, 2015, Cengage Learning India Pvt. Ltd. ISBN: 9788131525203

3. Practical Physics, G. L. Squires, 2015, 4/e, Cambridge University Press, ISBN- 9781139164498

4. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11/e, 2011, Kitab Mahal. ISBN-13 : 978-8122500844.

<table>
<tr><td colspan="9">1. Name of the Department: Physics</td></tr>
<tr><td colspan="2">2. Course Name</td><td>Statistical Mechanics</td><td>L</td><td colspan="3">T</td><td colspan="2">P</td></tr>
<tr><td colspan="2">3. Course Code</td><td>17080105</td><td>3</td><td colspan="3">0</td><td colspan="2">0</td></tr>
<tr><td colspan="3">4. Type of Course (use tick mark)</td><td>Core (√)</td><td colspan="3">DSE ()</td><td colspan="2">SEC ()</td></tr>
<tr><td colspan="2">5. Pre-requisite (if any)</td><td></td><td>6. Frequency (use tick marks)</td><td colspan="2">Even ()</td><td>Odd (√)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="9">7. Total Number of Lectures, Tutorials, Practical</td></tr>
<tr><td colspan="3">Lectures = 40</td><td colspan="2">Tutorials = 0</td><td colspan="4">Practical = 0</td></tr>
<tr><td colspan="9">8. Brief Syllabus:</td></tr>
<tr><td colspan="9">The course is intended to provide an understanding of the phase space and quantum space, canonical systems, in Bose-Einstein condensation, Ising model, random walk, Brownian motion and many more physical phenomenon which cannot be explained using classical mechanics principles.</td></tr>
<tr><td colspan="9">9. Learning objectives:</td></tr>
<tr><td colspan="9">The course aims to provide students with an understanding of the basics of phase space, ensembles, and different types of system like canonical, micro-canonical and grand-canonical system. To develop understanding of writing partition functions for these systems.</td></tr>
<tr><td colspan="9">10. Course Outcomes (COs):</td></tr>
<tr><td colspan="9">After the successful completion of the course, students would be able to
1. Understand phase space and canonical system.
2. Write partition functions for the canonical, micro-canonical and grand-canonical systems.
3. Understand the thermodynamic behavior of an Ideal Bose gas and an Ideal Fermi gas
4. Describe the basic involved in Bose-Einstein condensation, Ising model, random walk and Brownian motion.</td></tr>
<tr><td colspan="9">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td colspan="2">Number of lectures = 8</td><td colspan="6">Title of the unit: Basics of statistical mechanics</td></tr>
<tr><td colspan="9">Scope and aim of statistical mechanics. Transition from thermodynamics to statistical mechanics. Review of the ideas of phase space, phase points, Ensemble, Density of phase points. Liouville’s equation and Liouville’s theorem</td></tr>
<tr><td>Unit - 2</td><td colspan="2">Number of lectures = 12</td><td colspan="6">Title of the unit: Canonical systems</td></tr>
<tr><td colspan="9">Stationary ensembles: Micro canonical, canonical and grand canonical ensembles. Partition function formulation. Fluctuation in energy and particle. Equilibrium properties of ideal systems: ideal gas, Harmonic oscillators, rigid rotators. Para magnetism, concept of negative temperature.</td></tr>
<tr><td>Unit – 3</td><td colspan="2">Number of lectures = 12</td><td colspan="6">Title of the unit: Quantum mechanical ensembles</td></tr>
</table>

Quantum states and phase space; an ideal gas in quantum mechanical ensembles; Ideal Bose system, basic concepts and thermodynamic behavior of an Ideal Bose gas; Bose-Einstein condensation; Ideal Fermi systems; the thermodynamic behavior of an Ideal Fermi gas, discussion of heat capacity of a free electron gas at low temperatures; Pauli parameters, Boltzmann H-Theorem		
Unit – 4	**Number of lectures = 8**	**Title of the unit: Different models**
A dynamical model of phase transitions, Critical indices, Ising model, Thermodynamic fluctuations, random walk, Brownian motion, introduction to non-equilibrium processes, diffusion equation.		

11. Brief Description of self-learning / E-learning component:

To understand basic concepts in detail, students may get study materials on following links.

https://onlinecourses.nptel.ac.in/noc18_ph02

https://www.cmi.ac.in/~kpnmurthy/StatisticalMechanics2017/book.pdf

12. Books Recommended

1. R.K. Patharia. Statistical Mechanics. 2nd ed. Oxford: Butterworth-Heinemann. ASIN: B0092L8L2W.
2. K. Huang. Statistical Mechanics. New Delhi: Wiley Eastern. ISBN-10: 0471815187.
3. B.K. Agarwal and M. Eisner. Statistical Mechanics. New Delhi: Wiley Eastern. ISBN-10: 8122411576.
4. C. Kittel. Elementary Statistical Physics. New York: John Wiley. ISBN-10: 0486435148.
5. S.K. Sinha. Statistical Mechanics. New Delhi: Tata McGraw Hill. ISBN-10: 8173197172.
6. Suresh Chandra. Textbook of Statistical Mechanics. New Delhi: CBS Publishers. ISBN-10: 8123916086.

<table>
<tr><td colspan="7">1. Name of the Department: Physics</td></tr>
<tr><td>2. Course Name</td><td>Statistical Mechanics Lab</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td>17080106</td><td>0</td><td colspan="2">0</td><td colspan="2">4</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core (√)</td><td colspan="2">DSE ()</td><td colspan="2">SEC ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td></td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (√)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical</td></tr>
<tr><td colspan="2">Lectures = 0</td><td colspan="2">Tutorials = 0</td><td colspan="3">Practical = 52</td></tr>
<tr><td colspan="7">8. Course Description:</td></tr>
<tr><td colspan="7">In this course student will gain the practical knowledge about thermocouple & its calibration, Brownian motion, random walk etc</td></tr>
<tr><td colspan="7">9. Course Objectives:</td></tr>
<tr><td colspan="7">To determine various parameters like Boltzman constant, coefficient of thermal conductivity, thermo emf, cooling temperature of a hot object etc.</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs):</td></tr>
<tr><td colspan="7">After successful completion of the course, students will be able to
Correlate the theoretical concepts and identify its practical applications through experiments.</td></tr>
<tr><td colspan="7">11. List of Experiments</td></tr>
<tr><td colspan="7">1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne’s constant flow method.
2. Measurement of Planck’s constant using black body radiation.
3. To calibrate Resistance Temperature Device (RTD) using Null Method/Off-Balance Bridge.
4. To study the thermocouple and plot the graph between thermo emf vs temperature.
5. Calibration of a thermocouple by potential meter
6. To study the random walk using MATLAB/Python
7. To study the Brownian motion using MATLAB/Python
8. To calculate probability distribution function using MATLAB/Python
9. To determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton’s</td></tr>
</table>

disc method.

10. To determine the coefficient of thermal conductivity of copper by Searle's Apparatus.
11. To record and analyze the cooling temperature of a hot object as a function of time using a thermocouple and suitable data acquisition system.

Note: The list of the experiment given above should be considered as suggestive of the standard and available equipment. The faculty members are authorised to add or delete from this list whenever considered necessary.

12. Book Recommended

1. R. A. Dunlup. Experimental Physics: Modern Methods. New Delhi: Oxford University Press, ISBN- 0195049497.
2. Introduction to Matlab 7 1st Edition 2009 by ETTER, PEARSON INDIA. ISBN-9788131723135
3. B.K. Agarwal and M. Eisner. Statistical Mechanics. New Delhi: Wiley Eastern. ISBN-10: 8122411576

Semester-II

<table>
<tr><td colspan="7">1. Name of the Department: Physics</td></tr>
<tr><td>2. Course Name</td><td>Quantum Mechanics</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td>17080201</td><td>3</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core (√)</td><td colspan="2">DSE ()</td><td colspan="2">SEC ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td></td><td>6. Frequency (use tick marks)</td><td>Even (√)</td><td>Odd ()</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical</td></tr>
<tr><td colspan="2">Lectures = 40</td><td colspan="2">Tutorials = 0</td><td colspan="3">Practical = 0</td></tr>
<tr><td colspan="7">8. Course Description:</td></tr>
<tr><td colspan="7">This course will give an introduction to quantum mechanics, beginning with wave mechanics, angular momentum, time evolution, the simple harmonic oscillator, bra-ket notation. The students will also be made familiar with time independent and independent perturbation theory applied to various problems.</td></tr>
<tr><td colspan="7">9. Course Objectives:</td></tr>
<tr><td colspan="7">To give exposure about the various tools employed to analyse the quantum mechanical problems.</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs):</td></tr>
<tr><td colspan="7">1. Student will have understanding of Quantum Physics knowledge.
2. This course will help student in critical thinking and problem Solving
3. Quantum Mechanics course will develop research related skills
4. This course will develop Analytical/Scientific Reasoning in area of Quantum Mechanics</td></tr>
<tr><td colspan="7">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: General formalism of quantum & Schrodinger equations with applications</td></tr>
<tr><td colspan="7">The Schrödinger equations, time dependent and time independent forms, probability current density, expectation values, Ehrenfest's theorem, Gaussian wave packet and its spreading., Exact statement and proof of the uncertainty principle, eigen values and Eigen functions, wave function in coordinate and momentum representations. Application of Schrodinger equation for a particle in one dimensional Box, tunnelling problem and linear harmonic oscillator.</td></tr>
<tr><td>Unit – 2</td><td>Number of lectures = 8</td><td colspan="5">Title of the unit: Quantum operators</td></tr>
<tr><td colspan="7">Operator in quantum mechanics, Hermitian operator and Unitary operator change of basis, Eigen values and eigenvectors of operators, Dirac s Bra and Ket algebra, Linear harmonic oscillator, coherent states, Time development of states and operators, Heisenberg, Schrodinger and interactive</td></tr>
</table>

pictures.

Unit – 3	**Number of lectures** = 12	**Title of the unit: Angular momentum**

The angular momentum operators and their representation in spherical polar coordinates, Solution of Schrodinger equation for spherically symmetric (central) potentials, spherical harmonics, Hydrogen atom. Commutators and various commutation relations. Eigen values and eigenvectors of L2 and Lz.

Unit – 4	**Number of lectures** = 10	**Approximation methods**

Time independent perturbation theory, non-degenerate case, first and second order perturbation, WKB Approximation: WKB method for one-dimensional problems, Application to barrier penetration, WKB method for three dimensional problems, Time-dependent perturbation theory: General expression for the probability of transition from one state to another, harmonic perturbation

12. Brief Description of self-learning / E-learning component

http://nptel.ac.in/courses/115106066/

https://ocw.mit.edu/courses/physics/8-04-quantum-physics-i-spring-2016/lecture-notes/

https://www.ks.uiuc.edu/Services/Class/PHYS480/qm_PDF/QM_Book.pdf

13. Books Recommended

1. Schiff. Quantum Mechanics. New Delhi: Tata McGraw-Hill.ISBN: 9780070702431, 9780070702431

2. B. Craseman and J.L. Powell. Quantum Mechanics. New Delhi: Narosa. ISBN-13: 978-0201059205

ISBN-10: 0201059207

3. S. Gasiorowicz. Quantum Mechanics. New York: John Wiley.ISBN: 978-0-471-05700-0

4. J.J. Sakurai. Modern Quantum Mechanics. Addison Wesley.ISBN-10 : 0201539292, ISBN-13 : 978-0201539295

5. P.M. Mathews and K. Venkatesan. Quantum Mechanics. New Delhi: Tata McGraw-Hill.ISBN 10: 0070965102ISBN 13: 9780070965102

6. Ghatak and Loknathan. Quantum Mechanics. ISBN-10 : 9351382966, ISBN-13 : 978-9351382966

7. M.P. Khanna. Quantum Mechanics. New Delhi: HarAnand.SBN-10 : 812410400X, ISBN-13 : 978-8124104002

8. V.K. Thankappan. Quantum Mechanics. New Delhi: New Age International.ISBN-10 : 9386649217

ISBN-13 : 978-9386649218

9. N. Zettili. Quantum Mechanics: Concepts and Applications.ISBN-10 : 812656105X, ISBN-13 : 978-8126561056

1. Name of the Department: Physics						
2. **Course Name**	**Quantum Mechanics-Lab**	**L**	**T**		**P**	
3. Course Code	17080202	0	0		4	
4. Type of Course (use tick mark)		Core (√)	**DSE ()**		**SEC ()**	
5. Pre-requisite (if any)		**18. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()
6. Total Number of Lectures, Tutorials, Practical						
Lectures = 0		**Tutorials = 0**	**Practical = 52**			

7. Course Description:

In this course student will gain the practical and simulation knowledge about the reflection and transmission of a plane quantum wave at a 1D Woods-Saxon potential, Schrödinger Equation for arbitrary potential, Energy levels with corresponding eigenfunctions, Quantum mechanical scattering problem, of Electron spin resonance- determine magnetic field as a function of the resonance frequency etc.

8. Course Objectives:

1. To study Discrete energy label in Quantum mechanics
2. To study quantum mechanical scattering problem
3. Numerical and exact solution for Schrodinger equation for Particle in a box Quantum harmonic oscillator
4. To study of Zeeman Effect: with external magnetic field; Hyperfine splitting

9. Course Outcomes (COs):

1. Demonstrate the comprehensive and theoretical knowledge of Quantum Mechanics and Schrödinger equations with Angular Momentum operator and representation
2. Various tools to calculate Eigen values and total angular momentum of particles
3. Study of Approximation Method and scientific Time indepdent and dependent perturbation theory
4. To analyze quantum & Schrodinger equations based research and with its applications

10. List of Experiments

1. Eigen Energy Solver for Schrödinger Equation for arbitrary potential (Computational and simulation)
2. GaAs Single Quantum Well (Computational and simulation)
(Calculates the energy levels vs. well widths in a GaAs QW and their corresponding eigenfunctions)
3. Discrete variable representation (DVR) in 1D Quantum Mechanics (Computational and simulation)
4. Gaussian wave packet as solution of the free Schrödinger equation (Computational and siulation)
5. The quantum mechanical binding problem (Computational and simulation)
6. The quantum mechanical scattering problem (Computational and simulation)
(In this practical we will calculate the reflection and transmission of a plane quantum wave at a 1D Woods-Saxon potential using an approach that considers the incoming, the reflected and the transmitted wave parts)
7. Numerical and exact solution for Schrodinger equation for Particle in a box Quantum harmonic oscillator (Computational and simulation)

8. Excited States of Quantum Harmonic Oscillator using Raising Operator (Computational and simulation) Laboratory Based Experiments: 9. Study of Electron spin resonance- determine magnetic field as a function of the resonance frequency 10. Study of Zeeman Effect: with external magnetic field; Hyperfine splitting 11. Quantum efficiency of CCD **Note:** The list of the experiment given above should be considered as suggestive of the standard and available equipment. The faculty members are authorised to add or delete from this list whenever considered necessary.
11. Book Recommended
1. Schaum's outline of Programming with C++. J. Hubbard, 2000, McGraw-Hill Publication 2. An introduction to computational Physics, T. Pang, 2nd Edn.,2006, Cambridge Univ. Press 3. Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific & Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández.2014 Springer. 4. Scilab (A Free Software to Matlab): H. Ramchandran, A.S. Nair. 2011 S. Chand & amp; Co. 5. A Guide to MATLAB, B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, 2014, 3rd Edn., Cambridge University Press.

<table>
<tr><td colspan="7">1. Name of the Department: Physics</td></tr>
<tr><td>2. Course Name</td><td>Electrodynamics & Plasma Physics</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td>17080203</td><td>3</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core (√)</td><td colspan="2">DSE ()</td><td colspan="2">SEC ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td></td><td>6. Frequency (use tick marks)</td><td>Even (√)</td><td>Odd ()</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical</td></tr>
<tr><td colspan="2">Lectures = 40</td><td colspan="2">Tutorials = 0</td><td colspan="3">Practical = 0</td></tr>
<tr><td colspan="7">8. Course Description:</td></tr>
<tr><td colspan="7">This course aims to provide students with an introduction to the principles and behaviour of dynamical electric and magnetic systems, and a theoretical foundation in classical field theory. Plasma physics is an important subject for a large number of research areas. The primary learning outcome for this course is for the students to learn the basic principles and main equations of plasma physics, at an introductory level, with emphasis on topics of broad applicability.</td></tr>
<tr><td colspan="7">9. Course Objectives:</td></tr>
<tr><td colspan="7">To apprise the students regarding the concepts of electrodynamics and its use in various situations. To have a working understanding of the elements of Plasma Physics on topics including: Basic plasma properties; Motion of charged particles in magnetic field; Plasma waves and kinetic representation of plasmas.</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs):</td></tr>
<tr><td colspan="7">1. Student will have understanding of evaluate fields and forces in Electrodynamics and Magneto dynamics using basic scientific method
2. This course will help student in critical thinking and problem solving based on electrodynamics using Maxwell’s equation and Boundary Conditions.
3. Electrodynamics and plasma physics will have scientific potential to analyze scientific idea and explanation to conclusion method of Images and its applications in branches of Physical Sciences
4. This course will develop Analytical/Scientific Reasoning in area of Electrodynamics and plasma physics.</td></tr>
<tr><td colspan="7">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td>Number of lectures = 12</td><td colspan="5">Title of the unit: Electrostatics</td></tr>
<tr><td colspan="7">Electric Field, Gauss Law, Differential form of Gauss Law, Electromagnetic scalar and vector potentials, Maxwell’s equations in terms of scalar and vector potentials, Non uniqueness of Electromagnetic potentials and concept of Gauge. Lorentz gauge and coulomb gauge. Boundary value</td></tr>
</table>

problem, Poisson and Laplace equations, Electrostatic potential energy and energy density.		
Unit - 2	**Number of lectures = 10**	**Title of the unit: Method of Images**
The method of electrical images. Point charge near an infinite grounded conducting plane, Spherical conductor near point charge: When the sphere is at zero potential or earthed, insulated conducting sphere near a point charge, when the sphere is kept insulated and carries a total charge e, Conducting sphere in a uniform electric field.		
Unit - 3	**Number of lectures = 10**	**Title of the unit: Electromagnetic Waves and Radiation by Moving Charges**
Wave equation, Reflection and Refraction of electromagnetic waves at a plane interface between dielectrics, Wave propagation in a non-conducting and conducting media, Fresnel relations, Brewster's angle, Wave guides: TE and TM modes in rectangular wave guides; Moving point charges, Retarded potentials, Lienard- Wiechart potentials for a point charge, The fields of moving charge particles, Total power radiated by a point charge: Larmor's formula and its relativistic generalization.		
Unit - 4	**Number of lectures = 8**	**Title of the unit: Plasma Physics**
Elementary concepts, Plasma Oscillation, Electron oscillation in plasma, Electronic oscillations when the motion of ions is also considered. Derivation of plasma oscillation using Maxwell's equation, Propagation of Electromagnetic waves in plasma containing a magnetic field Quasi neutrality of plasma, Debye shielding distance		
12. Brief Description of self learning / E-learning component		
http://nptel.ac.in/syllabus/95102023/ https://nptel.ac.in/courses/115102020/ https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-522-space-propulsion-spring-2015/lecture-notes/MIT16_522S15_Lecture8.pdf		
13. Books Recommended		
1. Classical Electrodynamics by J.D. Jackson. ISBN-13: 978-8126510948 2. Introduction to Electrodynamics by A. Z. Capri and P. V. Panat. ISBN 13: 9788173193293 3. Electrodynamics by S. P. Puri. ISBN NO. 9781842656587 4. Introduction to Electrodynamics by D. J. Griffiths. ISBN-13: 978-0138053260 5. Introduction to Plasma Physics by F. F. Chen. ISBN 978-1-4757-0459-4 6. Introduction to Plasma Theory by D. R Nicholson. ISBN-13: 978-0471090458		

1. Name of the Department: Physics						
2. **Course Name**	**Electrodynamics & Plasma Physics-Lab**	**L**	**T**		**P**	
3. Course Code	17080204	0	0		4	
4. Type of Course (use tick mark)		Core (√)	**DSE ()**		**SEC ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 0		**Tutorials = 0**		**Practical = 52**		

8. Course Description:

Through this course students will gain practical and simulation knowledge about Lorentz transformation, Boundary value problem with grounded sphere, field strength with variation magnetic field in a solenoid, Brewster's Law and Black body radiation etc.

9. Course Objectives:

1. Study of Lorentz transformation
2. Study with simulation Helmholtz coil Boundary value problem: charge over grounded sphere
3. Study specific e/m measurement
4. Study Brewster's law analysis

10. Course Outcomes (COs):

1. Student will have understanding of evaluate fields and forces in Electrodynamics and Magneto dynamics using basic scientific method

2. This course will help student in critical thinking and problem solving based on electrodynamics using Maxwell's equation and Boundary Conditions.

3. Electrodynamics and plasma physics will have scientific potential to analyze scientific idea and explanation to conclusion method of Images and its applications in branches of Physical Sciences
4. This course will develop Analytical/Scientific Reasoning in area of Electrodynamics and plasma physics.

11. List of Experiments

1. Lorentz transformation LT (Simulation and Computational)
2. Helmholtz coil (Simulation and Computational)
3. Boundary value problem: charge over grounded sphere (Simulation and Computational)
4. e/m Ratio measurements
5. Measurement of field strength B and its variation in a solenoid (determine dB/dx)
6. To determine self-inductance of a coil by Rayleigh's method and Anderson's bridge.
7. To determine the mutual inductance of two coils by Absolute method.
8. Black body Radiation
9. Measurement of charge sensitivity, current sensitivity and CDR of Ballistic Galvanometer

10. To verify Brewster's Law and to find the Brewster's angle.
11. To study the polarization of light by reflection and determine the polarizing angle for air-glass interface.
12. To study the reflection, refraction of microwaves
13. Production and characterization of plasma

Note: The list of the experiment given above should be considered as suggestive of the standard and available equipment. The faculty members are authorised to add or delete from this list whenever considered necessary.

12. Book Recommended:

1. Advanced Practical Physics for students, B.L.Flint & H.T.Worsnop, 1971, Asia Publishing House.
2. Engineering Practical Physics, S. Panigrahi and B.Mallick, 2015, Cengage Learning India Pvt. Ltd.
3. A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed.2011, Kitab Mahal.
4. Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press

<table>
<tr><td colspan="7">1. Name of the Department: Physics</td></tr>
<tr><td>2. Course Name</td><td>Atomic and Molecular Physics</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td>17080204</td><td>3</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core (√)</td><td colspan="2">DSE ()</td><td colspan="2">SEC ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td></td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (√)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical</td></tr>
<tr><td colspan="2">Lectures = 40</td><td colspan="2">Tutorials = 0</td><td colspan="3">Practical = 0</td></tr>
<tr><td colspan="7">8. Course Description:</td></tr>
<tr><td colspan="7">Atom and molecule are the fundamental unit for all matters in universe. Matter, whatever the states, is made of atoms. The properties of all matters are governed by the electronic structure of atom and molecule. They have individual properties like electronic, magnetic and optical properties, which are quite different from the collective properties of matter made of atoms and molecules. This course will enlighten the knowledge of atoms and molecules and build up the pre-requisite knowledge for all science and engineering field.</td></tr>
<tr><td colspan="7">9. Course Objectives:</td></tr>
<tr><td colspan="7">1.Comparing between atomic emission spectroscopy and atomic absorption spectroscopy; Optical spectroscopy, Atomic spectrum Molecular spectroscopy
2.Theory of magnetic energy, Anomalous Zeeman's effect and Landue splitting factor.
3.Molecular Spectra of diatomic molecules Vibrational and Rotational energy levels.
4.To learn basics of NMR & ESR.</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs):</td></tr>
<tr><td colspan="7">After going through this course, the students
1. Will acquire the knowledge of atoms and molecules and their significance in scientific studies
2. Understand the spectroscopy techniques to study various type of spectra
3. Learn and acquire skills to demonstrate and apply these techniques research and development
4. Will be able to utilize knowledge for innovation and scientific understanding for the benefit of society</td></tr>
<tr><td colspan="7">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td>Number of lectures = 11</td><td colspan="5">Title of the unit: Atomic Physics</td></tr>
<tr><td colspan="7">Space Quantisation and Stern-Gerlach Experiment, L-S And J-J Coupling: Terms of Equivalent and Non-Equivalent Electron Atom, Breit's Scheme, Normal and Anomalous Zeeman Effect, Paschen-Back Effect And Stark Effect, Hyperfine Structure Of Spectral Lines: Isotope Effects, Nuclear spin and Hyperfine Splitting, Intensity Ratio and Determination Of Nuclear Spin.</td></tr>
<tr><td>Unit - 2</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Microwave and Infra-Red Spectra</td></tr>
<tr><td colspan="7">Types Of Molecules, Diatomic Molecule as Rigid Rotator, its Energy Level, Spectra and Intensities Of Spectral Lines, Effect of Isotopic Substitution, Diatomic Molecule as Non-Rigid Rotator.</td></tr>
</table>

Vibrating Diatomic Molecule: Energy of A Diatomic Molecule, Simple Harmonic Oscillator, An-harmonic Oscillator, Diatomic Vibrating Rotator.		
Unit - 3	**Number of lectures = 10**	**Title of the unit: Electronic Spectra of Diatomic Molecules**
The Born-Oppenheimer Approximation, Vibrational Coarse Structure: Progressions, Intensity of Vibrational-Electronic Spectra: The Franck-Condon Principle, Dissociation Energy an Dissociation Products, Rotational Fine Structure Of Electronic-Vibration Transitions, The Fortrat Parabola, Pre-dissociation. Electronic Structure Of Diatomic Molecules.		
Unit - 4	**Number of lectures = 09**	**Title of the unit: Raman Spectroscopy**
Raman Spectroscopy, Experimental Arrangement For Raman Spectra, Classical Theory Of Raman Effect, Quantum Theory of Raman Effect, Rotational Raman Spectra, Vibrational Raman Spectra and Molecular Structure.		

12. Brief Description of self learning / E-learning component

For understanding the basic concepts in detail, students may get the study materials from these E-learning links

https://ocw.mit.edu/courses/physics/

https://nptel.ac.in/courses/104104085/

https://nptel.ac.in/courses/115105100/56

13. Books Recommended

1. Collin N Banwell and Elaine M McCash, Fundamentals of Molecular Spectroscopy 4th edition: Tata McGraw- Hill (ISBN: 978-9352601738).
2. Raj Kumar, Atomic, Molecular Spectra: Laser, KedarNath Ram Nath (ISBN: 978-9380803302).
3. H Kaur, Spectroscopy: Pragati Prakashan (ISBN: 978-9386306425).
4. Atomic spectra & atomic structure, Gerhard Hertzberg: Dover publication, New York (ISBN: 978-0486601151)

<table>
<tr><td colspan="7">1. Name of the Department: Physics</td></tr>
<tr><td>2. Course Name</td><td>Atomic and Molecular Physics-Lab</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td>17080206</td><td>0</td><td colspan="2">0</td><td colspan="2">4</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core (√)</td><td colspan="2">DSE ()</td><td colspan="2">SEC ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td></td><td>6. Frequency (use tick marks)</td><td>Even (√)</td><td>Odd ()</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical</td></tr>
<tr><td colspan="2">Lectures = 0</td><td colspan="2">Tutorials = 0</td><td colspan="3">Hours = 52</td></tr>
</table>

8. Course Description:

Atom and molecule are the fundamental unit for all matters in universe. Matter, whatever the states, is made of atoms. The properties of all matters are governed by the electronic structure of atom and molecule. They have individual properties like electronic, magnetic and optical properties, which are quite different from the collective properties of matter made of atoms and molecules. This course will enlighten the practical knowledge of atoms and molecules by learning through experiments and build up the pre-requisite knowledge for all science and engineering field.

9. Course Objectives:

1. Comparing between atomic emission spectroscopy and atomic absorption spectroscopy; Optical spectroscopy, Atomic spectrum
2. Molecular spectroscopy
3. Molecular Spectra of diatomic molecules Vibrational and Rotational energy levels.

10. Course Outcomes (COs):

Acquire practical knowledge of

1. Measurement and analysis of different types of spectra
2. Applications of Raman spectroscopy in study of molecules
3. State and explain the key properties of many electron atoms.
4. Explain the observed dependence of atomic spectral lines on externally applied electric and magnetic fields.
5. State and justify the selection rules for various optical spectroscopies in terms of the symmetries of molecular vibrations.

11. List of Experiments (Perform at least eight experiments)

1. Study of Fine structure of Hg Spectral lines using constant deviation spectrometer
2. Study of Hyperfine structure using Febry Perot’s Interferometer
3. Raman scattering using a Laser source

4. Measurement and analysis of atomic spectra
5. Measurement and analysis of electronic spectra of Molecules
6. Measurement and analysis of electronic spectra of liquids
7. Measurement and analysis of vibrational spectra of Molecules
8. Measurement and analysis of rotational spectra of Molecules
9. Measurement and analysis of Raman spectra of liquids
10. Measurement and analysis of Raman spectra of Molecules
11. Measurement and analysis of absorption spectra of solids
12. Determination of Hall coefficient
13. Analysis of Rotational spectrum of N_2 (Raman Spectrum)
14. Analysis of Rotational –vibrational spectrum of di-atomic molecule.
15. Analysis of Band spectrum of molecules.

Note: The list of the experiment given above should be considered as suggestive of the standard and available equipment. The faculty members are authorised to add or delete from this list whenever considered necessary.

For understanding the basic concepts in detail, students may get the study materials from these E-learning links

https://ocw.mit.edu/courses/physics/

https://nptel.ac.in/courses/104104085/

https://nptel.ac.in/courses/115105100/56

12. Books Recommended

1. Advanced Practical Physics for students, B.L. Flint & H.T. Worsnop (1979), Asia Publishing House (ISBN-13 : 978-0423738902)
2. Advanced level Physics Practical's, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted (I 985), Heinemann Educational Publishers
3. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, I I th Edition, (2011), Kitab Mahal, New Delhi.(ISBN-13 : 978-8122500844; ISBN-10 : 8122500846)
4. Physics Lab Manual, Misra and Misra, (2000), South Asian Publishers (ISBN 10: 8170032962 / ISBN 13: 9788170032960)
5. Experiments in Modern Physics, H. Mark, N.Thomas Olson (1966), McGraw Hill (ISBN 10: 007040383X ISBN 13: 9780070403833)
6. Advanced Practical Physics Vol. II, S.P.Singh (2017), Pragati Prakashan (ISBN:: 978-93-86306-93-7;)

Discipline Specific Elective Course (DSEC)

Semester-III

Electronics

<table>
<tr><td colspan="8">1. Name of the Department: Physics</td></tr>
<tr><td>2. Course Name</td><td>Semiconductor Devices</td><td>L</td><td colspan="2">T</td><td colspan="3">P</td></tr>
<tr><td>3. Course Code</td><td>17080303</td><td>3</td><td colspan="2">0</td><td colspan="3">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">DSE (√)</td><td colspan="3">SEC ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Physics at graduation level</td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (√)</td><td colspan="2">Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="8">7. Total Number of Lectures, Tutorials, Practical</td></tr>
<tr><td colspan="2">Lectures = 40</td><td colspan="2">Tutorials = 0</td><td colspan="4">Practical = 0</td></tr>
<tr><td colspan="8">8. Course Description:</td></tr>
<tr><td colspan="8">The course is intended to provide an understanding of the semiconductor devices used in the current semiconductor industry. It caters to undergraduate and graduate students with a diverse background in Materials Science, and Physics. The course provides the students with the basic physics behind semiconductor materials, types of semiconductors, and the reason for the dominance of silicon in the electronics industry. The course also covers the basics of devices with emphasis on their electronic characteristics. Optical devices like LEDs, lasers, solar cells, and their properties will also be explained.</td></tr>
<tr><td colspan="8">9. Course Objectives:</td></tr>
<tr><td colspan="8">1. To study the basics of electronic components
2. To study the basic concept and characteristics of electronic devices and circuits.
3. To observe the characteristics of optical devices like LED, lasers and Solar cells
4. To get familiar with the different types of operational amplifiers</td></tr>
<tr><td colspan="8">10. Course Outcomes (COs):</td></tr>
<tr><td colspan="8">After successful completion of the course, students will be able to
1. Apply the concept of semiconductor physics
2. Apply the concepts of basic electronic devices to design various electronic circuits
3. Understand operation of diodes, transistors (JFET, MOSFET) in order to design basic and advanced circuits
4. Understand the working principle and uses of Solar Cell, PIN diodes and LEDs in practical life
5. Design of electronic circuits using Op-Amp for various practical applications</td></tr>
<tr><td colspan="8">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td>Number of lectures = 12</td><td colspan="6">Title of the unit: Basic Semiconductor Devices</td></tr>
</table>

P-N junction diode, Capacitance of p-n junctions, switching diodes, Clippers & Clampers, Photoconductors, photodiode, light emitting diodes and liquid crystal display, Junction Field Effect Transistor (JFET) : Basic structure & Operation, pinch off voltage, Single ended geometry of JFET, Volt Ampere characteristic, Transfer Characteristics, JFET as Switch and Amplifier. MOSFET: Enhancement MOSFET, Threshold Voltage, Depletion MOSFET, comparison of p & n Channel FET, SCR, 4-layer pnpn devices, Tunnel diode

Unit - 2	**Number of lectures = 8**	**Title of the unit: Optoelectronic Devices**

Radiative and non-radiative transitions, Solar Cell: basic characteristics, radiation effects and fill factor, Light dependent resistance (LDR), photodiodes, PIN diodes, metal semiconductor, avalanche photodiode, Light emitting diodes (LEDs), semiconductor diode lasers, Photo transistor.

Unit – 3	**Number of lectures = 10**	**Title of the unit: MOS systems and SPICE**

Metal semiconductor contacts, Ideal MS contacts, Schottky barriers and ohmic contacts, Oxide and interface charges, Origin of oxide charges, MOS structure, Effect of bias voltage Capacitance of MOS system, Introduction to electrical computer simulation, SPICE and its evaluations, Electrical circuit specifications, The SPICE DC analysis.

Unit - 4	**Number of lectures = 10**	**Title of the unit: Operational Amplifier**

Differential Amplifier: Circuit configuration, dual input balanced output different amplifier, Inverting and Non-inverting inputs, CMRR, Operational Amplifiers: Block diagram, open and close loop configuration, inverting & non-inverting amplifier, Op-amp with negative feedback Voltage series feedback, Effect of feedback on closed loop voltage gain, Input resistance, output resistance, band width, output offset voltage, Measurements of Op-amp parameters. Op-amp Application: D.C. and A.C. amplifier, summing, scaling and Averaging amplifier, Integrator, Differentiator, Electronic analog computation comparator.

12. Brief Description of self-learning / E-learning component

For understanding the basic concepts in detail, students may get the study materials from these E-learning links

https://ocw.mit.edu/courses/physics/

https://nptel.ac.in/courses/117107094/

https://www.youtube.com/watch?v=CeD2L6KbtVM

13. Books Recommended

1. J. Millman and C. C. Halkies, Integrated Electronics. Tata McGraw-Hill, ISBN: 978-0-07-462245-2.
2. R. P. Jain. Modern Digital Electronics, Tata McGraw Hills, ISBN: 9780070669116
3. Malvino and Leach, Digital Electronics, ISBN- 978-0-07-014170-4
4. S. M. Sze, Semiconductor Devices: Physics and Technology, ISBN-13: 978-8126516810
5. Ramakanth A. Gayakwad, Op-Amps & Linear Integrated Circuits. 2nd ed, ISBN-13: 978-8120320581
6. A.P. Malvino and Donald, Principal and Application in Electronics. Tata McGraw-Hill, ISBN : 0070141703

7. J. D. Rayder, Fundamental of electronics, ISBN-13: 978-8120300828

<table>
<tr><td colspan="7">1. Name of the Department: Physics</td></tr>
<tr><td>2. Course Name</td><td>Semiconductor Devices Lab</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td>17080304</td><td>0</td><td colspan="2">0</td><td colspan="2">4</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">DSE (√)</td><td colspan="2">SEC ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td></td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (√)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical</td></tr>
<tr><td colspan="2">Lectures = 0</td><td colspan="2">Tutorials = 0</td><td colspan="3">Practical = 52</td></tr>
<tr><td colspan="7">8. Course Description:</td></tr>
<tr><td colspan="7">In this course students will gain practical knowledge about various semiconductor and optoelectronic devices like JFET, MOSFET, LED etc. and use of op amp for different arithmetic operations.</td></tr>
<tr><td colspan="7">9. Course Objectives:</td></tr>
<tr><td colspan="7">To study the characteristics of JFET, MOSFET, SCR, Solar cell
To use Op-amp for different arithmetic operations, square, ramp generator and Wein bridge oscillator</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs):</td></tr>
<tr><td colspan="7">After successful completion of the course, students will be able to
Correlate the theoretical concepts and identify its practical applications through experiment procedure and results.</td></tr>
<tr><td colspan="7">11. List of Experiments</td></tr>
</table>

1. To study the characteristics of Junction Field Effect Transistor. 2. To study the characteristics of Metal Oxide Semiconductor Field Effect Transistor 3. To study the characteristics of SCR and its application as a switching device. 4. To use Op-Amp for different Arithmetic Operations. 5. To use Op-Amp as Square, Ramp Generator and Wien Bridge Oscillator 6. To study the characteristics of a solar cell and calculate its fill factor. 7. To design an (i) inverting amplifier and (ii) non-inverting amplifier, of a given gain using operational amplifier. 8. To use Op-Amp as Full Wave Rectifier. 9. To study the characteristics of optoelectronics Devices (LED, photo-detector). 10. To design combinational Logic Circuits. **Note:** The list of the experiment given above should be considered as suggestive of the standard and available equipment. The faculty members are authorised to add or delete from this list whenever considered necessary.
12. Book Recommended:
1. R. A. Dunlup. Experimental Physics: Modern Methods. New Delhi: Oxford University Press, ISBN- 0195049497 2. B. K. Jones. Electronics for Experimentation and Research. Prentice-Hall, ISBN 13: 9780132507547

1. Name of the Department: Physics						
2. Course Name	**Digital Electronics**	**L**	**T**		**P**	
3. Course Code	17080305	3	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**		**SEC ()**	
5. Pre-requisite (if any)	Physics at graduation level	**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 40		**Tutorials = 0**	**Practical = 0**			
8. Course Description:						
This course will deepen your understanding of the Number system, Boolean Algebra, logic gates, Flip Flops and A/D and D/A convertors						
9. Course Objectives:						
1. To study the working principle logic gates. 2. To study the basic of flip-flops, memory devices and its related electronic circuits. 3. To understand the different types of logic circuits and its various application. 4. To study the basics of A/D and D/A convertors.						

5. To study the basic of shift registers and counters

10. Course Outcomes (COs):

After successful completion of the course, students will

1. have a basic knowledge of various number system and Boolean Algebra.
2. understand the concept of working of different types of logic gates.
3. be able to design the electronic circuits like Flip Flop, RAM, ROM using different types of logic gates.
4. Understand the basic of shift registers & counters and their uses in design of advance electronic equipments
5. know basic D/A & A/D Converters and their applications in communication system.

11. Unit wise detailed content

Unit-1	**Number of lectures = 12**	**Title of the unit: Various Number system, Boolean Algebra and Combinational Logic**

Various Number system and their arithmetic: binary number system, 2's compliment, Octal number system, hexadecimal number system, BCD codes, Gray codes, Review of Boolean Laws & Theorems; Logic Families; TTL NAND operation, Gate circuits; Standard forms of Boolean expressions (SOP & POS form) and their implantation; Karnaugh simplification of SOP & POS expressions, Don't care conditions. Multiplexer and Demultiplexer; Comparators, Encoder and Decoder; Parity generators and checkers, Adder-Subtract circuits

Unit - 2	**Number of lectures = 10**	**Title of the unit: Flip Flops and Memory Devices**

Flip-Flops: Clock waveform and its characteristics; RS, JK, JK master slave, Timer-555, D and T Flip Flops. Memories: ROM, PROM and EPROM, RAM, Static and Dynamic Random Access Memories (SRAM and DRAM), content addressable memory, other advanced memories.

Unit - 3	**Number of lectures = 8**	**Title of the unit: Shift Registers and Counters**

Types of Registers: Buffer register, control register, Shift Registers (SISO, SIPO, PISO and PIPO), Control shift register; Counters: Modulus of Counter; ripple counters, ring counter, Asynchronous 2-bit, Up/Down and decade counter; Design of synchronous counter (Mod-8), TTL counter.

Unit - 4	**Number of lectures = 10**	**Title of the unit: D/A and A/D Converters**

D/A Convertors: Weighted Register Network and R-2R Network, A/D Converters: Parallel comparator A/D converter, successive approximation A/D converter, Counting A/D converter, Dual slope A/D converter, A/D converter using voltage to frequency and voltage to time conversion – accuracy and resolution. D/A converter resistive network, accuracy and resolution.

12. Brief Description of self learning / E-learning component

For understanding the basic concepts in detail, students may get the study materials from these E-learning links
https://ocw.mit.edu/courses/physics/
https://nptel.ac.in/courses/117107094/
https://www.youtube.com/watch?v=CeD2L6KbtVM

13. Books Recommended

1. Integrated electronics – Millman & Halkias, Tata McGraw-hill, ISBN-13: 978-0070151420
2. Microprocessor and Interfacing – D. V Hall, ISBN-13: 978-0070601673
3. Micropressor Architecture Prog. & Appls. , S. Goankar, Wiley-Estern, ISBN-13: 978-8187972099
4. Digital Computer Electronics – AP. Malvino, ISBN-13: 978- 0028005942
5. Advanced Electronic Communication system by Kennedy, ISBN-13: 978-9352606603
6. Modern digital electronics by R. P. Jain, ISBN-10: 0070681074

1. Name of the Department: Physics						
2. Course Name	**Digital Electronics Lab**	**L**	**T**		**P**	
3. Course Code	17080306	0	0		4	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**		**SEC ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 0		**Tutorials = 0**	**Practical = 52**			
8. Course Description:						
Through this course students will gain practical knowledge about circuit design and working of flip flops, UJT, coder –decoder, DAC, ADC etc.						
9. Course Objectives:						
To study JK, SR flip flop, multiplexer, demultiplexer, decoder, phase shifter and UJT. To study the working of DAC and ADC. To determine the CMRR, Input offset voltage and input off set current of an Op-amp. To determine hall coefficient						

10. Course Outcomes (COs):

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

Correlate the theoretical concepts of digital electronics and identify its practical applications through experiment procedure and results.

11. List of Experiments

1. To study SR and JK flip flop circuits using logic gates.
2. To study the UJT Characteristics.
3. To study the use of Digital Comparator.
4. To study use of multiplexer, de-multiplexer, decoder and phase shifter.
5. To measure input offset voltage, input bias current, input offset current and CMRR of Op-Amp.
6. To study the working of DAC and measure resolution and setting time of DAC.
7. To study working of ADC and measure resolution and conversion time of ADC.
8. Two probe method for resistivity measurement.
9. To study Hall effect in semiconductor to determine Hall voltage, concentration of charge carriers and the type of semiconductor etc.
10. To measure the band gap of Germanium using four probe method.

Note: The list of the experiment given above should be considered as suggestive of the standard and available equipment. The faculty members are authorised to add or delete from this list whenever considered necessary.

12. Book Recommended:

1. R. A. Dunlup. Experimental Physics: Modern Methods. New Delhi: Oxford University Press, ISBN- 0195049497
2. B. K. Jones. Electronics for Experimentation and Research. Prentice-Hall, ISBN 13: 9780132507547

1. Name of the Department: Physics						
2. Course Name	**Analog and Digital Communication**	**L**	**T**		**P**	
3. Course Code	17080307	3	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**		**SEC ()**	
5. Pre-requisite (if any)	Physics at graduation level	**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 40		**Tutorials = 0**	**Practical = 0**			
8. Course Description:						
This course will deepen your understanding of the different processes to grow the single crystal silicon which will help you to fabricate the different types of integrated circuits (ICs) for the particular applications. It also helps you to understand the techniques for making contact between						

semiconductor and metals.

9. Course Objectives:

1. To study the basics of analog communication system
2. To study the basics of digital modulation system.
3. To understand the sampling and quantization.
4. To get familiar with ASK, FSK, and PSK.

10. Course Outcomes (COs):

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

1. have a basic knowledge of analog and digital communication system
2. understand the techniques behind the sampling and quantization in digital communication
3. know the working principle of ASK, FSK, & PSK and their practical applications
4. have a basic knowledge of information theory and its uses in communication

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Analog Communication**
Basics of Communication system, Need of Modulation, Types of analog modulation, Amplitude Modulation, De-modulation of AM waves, Frequency Modulation, Phase Modulation, Transmitter (Block Diagram) and its characteristics feature, Super heterodyne receiver and its characteristics, Radar & Radar range equation.		
Unit – 2	**Number of lectures = 10**	**Title of the unit: Digital Modulation System**
Digital Modulation System: Sampling Theorem, Signal reconstruction in Time Domain, Practical and flat-top sampling, sampling of band pass signal; types of analog pulse modulation, method of generation and detection of PAM, PWM and PPM, spectra of pulse modulated system; Discretization in time and amplitude, Signal to quantization noise ratio, non-uniform quantizer; Encoding and Pulse Code Modulation, Band width of PCM, DPCM, DM, Idling noise and slope overload.		
Unit – 3	**Number of lectures = 10**	**Title of the unit: Digital Modulation Techniques**
Digital Modulation Technique: Fundamental of TDM, Electronic Commutator, Types of Digital Modulation, Waveform for ASK, FSK, and PSK, Differential Phase Shift Keying, QPSK and MSK		
Unit – 4	**Number of lectures = 10**	**Title of the unit: Information Theory**
Information Theory: Concept of Information Measure, Entropy and Information rate, conditional entropy and redundancy, Source coding, Fixed and variable length codes, Source coding theorem, Shannon–Fano and Huffman coding for 1st , 2nd and 3rd order extension, Mutual information and channel capacity of discrete memory less channel, Hartley – Shannon Law		

12. Brief Description of self-learning / E-learning component

For understanding the basic concepts in detail, students may get the study materials from these E-learning links
https://ocw.mit.edu/courses/physics/
https://nptel.ac.in/courses/108108111/3
https://nptel.ac.in/courses/117103066/7

13. Books Recommended

1. J. Millman and C. C. Halkies, Integrated Electronics. Tata McGraw-Hill, ISBN: 9781405127875
2. S. M. Sze, Semiconductor Devices: Physics and Technology, ISBN- 13: 978-0470537947
3. Ramakanth A. Gayakwad, Op-Amps & Linear Integrated Circuits. 2nd ed. 1991, ISBN-10: 0136371744
4. A.P. Malvino and Donald, Principal and Application in Electronics. Tata McGraw-Hill, ISBN : 0070141703
5. Thomas L. Floyd. Digital Electronics. New Delhi: Person, ISBN-13: 978-0132737968
6. A.D. Helfrick and W.D. Cooper, Modern electronics Instrumentation and Measurements Techniques, New

   Delhi: PHI, ISBN: 978-81-317-0888-0
7. J. D. Rayder, Fundamental of electronics, ISBN-13: 978-8120300828

1. Name of the Department: Physics						
2. Course Name	**Analog and Digital Communication**	**L**	**T**		**P**	
3. Course Code	17080308	0	0		4	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**		**SEC ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical		
Lectures = 0	**Tutorials = 0**	**Practical = 52**

8. Course Description:

Through this course students will gain practical knowledge about modulation and demodulation of the signals using techniques like AM, FM, PAM, PPM, PWM, etc.

9. Course Objectives:

- To study amplitude modulated (AM) and frequency modulated signals.
- To study demodulation of amplitude modulated (AM) signals.
- To determine modulation index in amplitude modulation.
- To study the characteristics of multivibrators

10. Course Outcomes (COs):

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

Correlate the theoretical concepts of Analog and Digital Communication and identify its practical applications through experiment procedure and results.

11. List of Experiments

i. Study of linear and square wave detector.

ii. Generation of amplitude modulated (AM) signals.

iii. To study the demodulation of amplitude modulated (AM) signals.

iv. To study the generation and detection of frequency modulated (FM) signals.

v. To observe the effect of modulation index in amplitude modulation.

vi. To understand the demodulation of an frequency modulated (FM) signals.

vii. Study of super heterodyne receiver.

viii. To study pulse amplitude, Pulse width and Pulse position modulations.

ix. To study the frequency response of an operational amplifier.

x. To study the characteristics of multivibrators – bistable, Astable, monostable.

Note: The list of the experiment given above should be considered as suggestive of the standard and available equipment. The faculty members are authorised to add or delete from this list whenever considered necessary.

12. Book Recommended:

1. R. A. Dunlup. Experimental Physics: Modern Methods. New Delhi: Oxford University Press, ISBN- 0195049497
2. B. K. Jones. Electronics for Experimentation and Research. Prentice-Hall, ISBN 13: 9780132507547

Condensed Matter Physics

1. Name of the Department: **Physics**				
2. **Course Name**	**Basic Concepts in Condensed Matter Physics**	**L**	**T**	**P**
3. Course Code	17080309	3	0	0
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**	**SEC ()**

5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical

Lectures = 40	**Tutorials =** 0	**Practical =** 0

8. Course Description:

This course intends to provide knowledge about the basic elements of condensed matter physics.

9. Course Objectives:

1. This course imparts knowledge about conceptual condensed matter physics.
2. This course aims to provide a general introduction to theoretical concepts in condensed matter physics.
3. This course aims to provide an introduction to the experimental topics in condensed matter physics.
4. This course aims to set a correlation between the academic and investigational studies.

10. Course Outcomes (COs):

1.The students will be able to apply the theoretical concepts of X-ray diffraction in crystals experimentally

2.Students will be able to explain and differentiate between the metals, insulators and semiconductors based upon the knowledge of band theory

3.Students will be able to understand the thermal properties of the solids and calculate the specific heats of the solids.

4.Based upon the theoretical concepts, students can calculate the crystal energies and analyze the types of bonding

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Crystal Lattices**

Diffraction of electromagnetic waves by crystals: X-rays, Electrons and Neutrons, Symmetry operations and classification of Bravais lattices, common crystal structures, reciprocal lattice, Brillouin zone, X-ray diffraction, Bragg's law, Von Laue's formulation, diffraction from non-crystalline systems. Geometrical factors of SC, FCC, BCC and diamond lattices; Basis of quasi crystals.

Unit - 2	**Number of lectures = 10**	**Title of the unit: Crystal Binding and Lattice Dynamics**

Bond classifications – types of crystal binding, covalent, molecular and ionic crystals, London theory of van der Waals, hydrogen bonding, cohesive and Madelung energy.

Failure of the static lattice model, adiabatic and harmonic approximation, vibrations of linear monoatomic lattice, one-dimensional lattice with basis, models of three-dimensional lattices, quantization of lattice vibrations, Einstein and Debye theories of specific heat, phonon density of states, neutron scattering.

Unit - 3	**Number of lectures = 12**	**Title of the unit: Metals and Band theory of Solids**

Drude theory, DC conductivity, magneto-resistance, thermal conductivity, thermoelectric effects, Fermi-Dirac distribution, thermal properties of an electron gas, Wiedemann-Franz law, critique of free-electron model.

Periodic potential and Bloch's theorem, weak potential approximation, density of states in different

dimensions, energy gaps, Fermi surface and Brillouin zones. Origin of energy bands and band gaps, effective mass, tight-binding approximation and calculation of simple band-structures. Motion of electrons in lattices, Wave packets of Bloch electrons, semi-classical equations of motion, motion in static electric and magnetic fields, theory of holes, cyclotron resonance.		
Unit - 4	**Number of lectures = 8**	**Title of the unit: Defects and Diffusion in Solids and Semiconductors**
Point defects: Frenkel defects, Schottky defects, examples of colour centres, line defects and dislocations. General properties and band structure, carrier statistics, impurities, intrinsic and extrinsic semiconductors, drift and diffusion currents, mobility, Hall effect.		
12. Brief Description of self learning / E-learning component		
https://nptel.ac.in/courses/115/105/115105099/ https://www.youtube.com/watch?v=RImqF8z91fU https://www.youtube.com/playlist?list=PL64fZsc8IYkVkb4Uf0esPJ5GUq6g0Og9s		
13. Books Recommended		
1. Introduction to Solid State Physics, Charles Kittel, John Wiley and Sons, ISBN: 978-8126535187 2. Solid State Physics, Neil W. Ashcroft and N. David Mermin, Holt, Rinehart and Winston, ISBN: 978-0030839931 3. Applied Solid State Physics, Rajnikant, Wiley India, ISBN: 9788126522835 4. Solid State Physics, S O Pillai, New Age International Publishers, ISBN: 978-9386070920 5. Elements of Solid State Physics, J P Srivastava, PHI Learning Private Limited, ISBN: 978-81-203-5066-3		

1. Name of the Department: Physics					
2. **Course Name**	**Basic Concepts in Condensed Matter Physics Lab**	**L**	**T**	**P**	
3. Course Code	17080310	0	0	4	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**	**SEC ()**	
5. Pre-requisite		**6. Frequency (use tick**	Even ()	Odd (√)	Either Sem ()	Every Sem ()

(if any)		marks)				

7. Total Number of Lectures, Tutorials, Practical

Lectures = 0	Tutorials = 0	Practical = 52

8. Course Description:

In this course students will gain practical knowledge about lattice dynamics, band gap and basic concepts of semiconductor devices

9. Course Objectives:

1. The major objective of this course is to make students understand the basic concepts of condensed matter physics through a standard set of experiments.
2. While performing these experiments students must correlate them with the corresponding theory
3. To make students practise thinking and to have hands on experience of the equipment
4. To make student acquire, process, analyse and interpret the data

10. Course Outcomes (COs):

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

1. Distinguish between the type of semiconductors and find their band gap
2. Analyze the mono and di-atomic lattice
3. apply different experimental techniques to calculate scientific parameters
4. correlate the theoretical concepts with the experiments

11. List of Experiments

1. To study Hall effect in semiconductor to determine Hall voltage, concentration of charge carriers and the type of semiconductor etc.
2. To measure the band gap of Germanium using four probe method.
3. Study of dispersion relation for the mono-atomic lattice – comparison with theory.
4. Determination of cut-off frequency of the mono atomic lattice
5. Study of the dispersion relation for the di-atomic lattice – acoustical mode and optical mode energy gap. Comparison with theory.
6. To draw forward and reversed bias characteristics of a semiconductor diode.
7. Zener Diode voltage regulation characteristics.
8. To determine the value of e/m by Thomson's method
9. To determine band gap using van der Paw technique
10. To determine the value of e/m by helical method

Note: The list of the experiment given above should be considered as suggestive of the standard and available equipment. The faculty members are authorised to add or delete from this list whenever considered necessary.

12. Book Recommended:

1. Harnam Singh and P S Hemne, Practical Physics, S Chand, ISBN: 9788121904698
2. R. A. Dunlup. Experimental Physics: Modern Methods. New Delhi: Oxford University Press, 978-0195049497

<table>
<tr><td colspan="7">1. Name of the Department: Physics</td></tr>
<tr><td>2. Course Name</td><td>Condensed Matter Physics: Physical Properties</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td>17080311</td><td>3</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">DSE (√)</td><td colspan="2">SEC ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td></td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (√)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical</td></tr>
<tr><td colspan="2">Lectures = 40</td><td colspan="2">Tutorials = 0</td><td colspan="3">Practical = 0</td></tr>
<tr><td colspan="7">8. Course Description:</td></tr>
<tr><td colspan="7">This course intends to provide knowledge about the Physical properties of solids.</td></tr>
</table>

9. Course Objectives:		
1. This course gives an insight about conceptual condensed matter physics. 2. This course delivers a general outline to theoretical concepts in condensed matter physics. 3. This course provides an introduction to the experimental topics in condensed matter physics. 4. This course aims to set a correlation between the academic and investigational studies.		
10. Course Outcomes (COs):		
1.The students will be able to find out about dielectric and ferroelectric materials 2.The student will come to know about the optical properties of solids which play an important role in crystal structure determination 3.Student will know the magnetic parameters and will be able to find potential materials for magnetic applications 4.Hall effect knowledge will make the students to recognize the p- or n-type semiconductors		
11. Unit wise detailed content		
Unit-1	**Number of lectures = 8**	**Title of the unit: Dielectric Properties of Solids**
: Dielectrics and ferroelectrics, macroscopic electric field, local field at an atom, dielectric constant and polarizability, ferroelectricity, antiferroelectricity, piezoelectric crystals, ferroelasticity, electrostriction.		
Unit - 2	**Number of lectures = 8**	**Title of the unit: Optical properties**
Optical constants and their physical significance, Reflectivity in metals, plasmonic properties of metals, determination of band gap in semiconductors: direct and indirect band gap, defect mediated optical transitions, excitons, photoluminescence, Electroluminesence.		
Unit - 3	**Number of lectures = 10**	**Title of the unit: Magnetism**
Types of magnetic materials, Quantum theory of paramagnetism, Hund's rule, Ferromagnetism, anti-ferromagnetism: molecular field, Curie temperature. Domain theory, Magnetic Anisotropy, Magnetic interactions, Heitler-London method, exchange and super exchange, magnetic moments and crystal-field effects, spin-wave excitations and thermodynamics, anti-ferromagnetism, Magnetostriction.		
Unit - 4	**Number of lectures = 14**	**Title of the unit: Transport Properties of Solids and Superconductors**
Boltzmann transport equation, resistivity of metals and semiconductors, Fermi surfaces – determination, Landau levels, de Hass van Alphen effect, Quantum Hall effect- Integral quantum Hall effect and magnetoresistance. Phenomenology, review of basic properties, thermodynamics of superconductors, London's equation and Meissner effect, Type-I and Type-II superconductors, BCS theory of superconductors.		
12. Brief Description of self-learning / E-learning component		
https://nptel.ac.in/courses/115/105/115105099/ https://www.youtube.com/watch?v=RImqF8z91fU https://www.youtube.com/playlist?list=PL64fZsc8IYkVkb4Uf0esPJ5GUq6g0Og9s		
13. Books Recommended		

1. Introduction to Solid State Physics, Charles Kittel, John Wiley and Sons, ISBN: 978-8126535187

2. Solid State Physics, Neil W. Ashcroft and N. David Mermin, Holt, Rinehart and Winston, ISBN: 978-0030839931

3. Applied Solid State Physics, Rajnikant, Wiley India, ISBN: 9788126522835

4. Solid State Physics, S O Pillai, New Age International Publishers, ISBN: 978-9386070920

5. Elements of Solid State Physics, J P Srivastava, PHI Learning Private Limited, 9789386070920

<table>
<tr><td colspan="7">1. Name of the Department: Physics</td></tr>
<tr><td>2. Course Name</td><td>Condensed Matter Physics: Physical Properties Lab</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td>17080312</td><td>0</td><td colspan="2">0</td><td colspan="2">4</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">DSE (√)</td><td colspan="2">SEC ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td></td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (√)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical</td></tr>
<tr><td colspan="2">Lectures = 0</td><td colspan="2">Tutorials = 0</td><td colspan="3">Practical = 52</td></tr>
</table>

8. Course Description:
In this course students will gain practical knowledge about optical, dielectric and magnetic properties of the materials.
9. Course Objectives:
1. The major objective of this course is to make students understand the basic concepts of condensed matter physics through standard set of experiments. 2. While performing these experiments students must correlate them with the corresponding theory 3. To make students practise thinking and to have hands on experience of the equipment 4. To make student acquire, process, analyse and interpret the data
10. Course Outcomes (COs):
After successful completion of the course, students will be able to 1. calculate various optical parameters 2. calculate the dielectric properties 3. apply different experimental techniques to calculate scientific parameters 4. associate the theoretical concepts with the experiments
11. List of Experiments
1. To determine the variation of refractive index of the material of prism and to verify Cauchy's dispersion formula. 2. To study the UV/vis spectrum of given sample. 3. To find the dielectric constant of liquids 4. To study Curie temperature of magnetic materials. 5. Dielectric constant and Curie temperature of ferroelectric ceramics. 6. To Study Hysteresis (B-H curve). 7. Two probe method for resistivity measurement. 8. To study conductivity of thin film by four probe method. 9. To find the magnetoresistance of semiconducting material 10. To study determine the change in length of the sample when placed in magnetic field. **Note:** The list of the experiment given above should be considered as suggestive of the standard and available equipment. The faculty members are authorised to add or delete from this list whenever considered necessary.
12. Book Recommended:
1. Harnam Singh and P S Hemne, Practical Physics, S Chand, ISBN: 9788121904698 2. R. A. Dunlup. Experimental Physics: Modern Methods. New Delhi: Oxford University Press, 978-0195049497

1. Name of the Department: **Physics**						
2. **Course Name**	**Advanced Condensed Matter Physics**	**L**	**T**		**P**	
3. Course Code	17080313	3	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**		**SEC ()**	
5. Pre-requisite		**6. Frequency**	Even ()	Odd (√)	Either Sem ()	Every Sem ()

(if any)		(use tick marks)				
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 40		**Tutorials** = 0		**Practical** = 0		
8. Course Description:						
This course intends to provide knowledge about the advanced concepts in condensed matter physics						
9. Course Objectives:						
1. This course intends to provide knowledge of emerging topics in condensed matter physics. 2. In addition, this course aims to provide introduction to theoretical aspects of advanced topics. 3. This course aims to provide an introduction to the experimental topics in condensed matter physics. 4. This course aims at inculcating conceptual know how in students						
10. Course Outcomes (COs):						
1.The students will have information about the carbon-based materials 2.Student will get basic knowledge about properties of different materials which have a wide range of applications in different spheres. 3.Students will be able to understand the ferroelectric phase transitions of first and second order. 4.The students will be exposed to different characterization techniques used in experimental condensed matter physics.						
11. Unit wise detailed content						
Unit-1	**Number of lectures = 10**	**Title of the unit: Glasses and Polymers**				
Glass formation, types of glasses and glass transition, radial distribution function and amorphous semiconductors, electronic structure of amorphous solids, localized and extended states, mobility edges, Density of states and their determination, transport in extended and localized states, Optical properties of amorphous semiconductors. Structure of polymers, polymerization mechanism, characterization techniques, optical, electrical, thermal and dielectric properties of polymers.						
Unit - 2	**Number of lectures = 8**	**Title of the unit: Liquid crystals**				
Liquid Crystals. Structural peculiarities and applications, Thermotropic liquid crystals; Classification, Phases and phase transitions; anisotropic materials; symmetry aspects; optics; electro-optics of liquid crystals; ferro-, and antiferroelectric liquid crystals; examples of LCs in nanoscience, photonics and microwave electronics, display devices.						
Unit - 3	**Number of lectures = 14**	**Title of the unit: Carbon based materials and Phase transitions in solids**				
Fullerenes, C60, C80 and C240 Nanostructures; Properties and Applications (mechanical, optical and electrical). CNT-single walled and multiwalled, graphene. Landau's theory, first order and second order transition, order parameter and critical exponents, examples of phase transition: Solid-liquid, ferroelectric – paraelectric, ferromagnetic – paramagnetic, superconducting transition, liquid crystals.						
Unit - 4	**Number of lectures = 8**	**Title of the unit: Introduction to Surface Physics**				
Reconstruction and relaxation, surface electronic structure; Hetrostructures; Self-assembled						

monolayers, Electrified interfaces, Charge transfer at the liquid-solid interfaces. Thin film deposition methods: thermal evaporation and sputtering.
12. Brief Description of self learning / E-learning component
https://nptel.ac.in/courses/118/104/118104008/ https://nptel.ac.in/courses/113/106/113106093/ https://nptel.ac.in/courses/113/107/113107081/ https://nptel.ac.in/courses/118/102/118102003/
13. Books Recommended
1. Physics of Amorphous Solids, R. Zallen (John Wiley and sons, 1983), ISBN: 978-0471299417 2. Introduction to Polymer Physics, Ulrich Eisele and Stephen D. Pask (Springer-Verlag, 2011), ISBN: 978-3642744365 3. The physics of liquid crystals, Pierre-Gilles de Gennes (2nd Ed., Oxford University Press, 2003), ISBN: 9780198520047 4. Introduction to Liquid Crystals, Peter J. Wojtowicz, E. Priestly, Ping Sheng (Plenum press, 1975), ISBN: 9780306308581 5. The Physics of Phase Transitions - Concepts and Applications, P. Papon, J. Leblond, and Paul H. E. Meijer (2nd Ed., Springer-Verlag, 2006), ISBN: 978-3-540-33390-6

1. Name of the Department: Physics				
2. Course Name	**Advanced Condensed Matter Physics Lab**	**L**	**T**	**P**
3. Course Code	17080314	0	0	4
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**	**SEC ()**

5. Pre-requisite (if any)		6. Frequency (use tick marks)	Even ()	Odd (√)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical		
Lectures = 0	**Tutorials = 0**	**Practical = 52**

8. Course Description:

In this course students will gain practical knowledge advanced experiments related to condensed matter physics

9. Course Objectives:

1. The major objective of this course is to make students understand the basic concepts of condensed matter physics through standard set of experiments.
2. While performing these experiments students must correlate them with the corresponding theory
3. To make students practise thinking and to have hands on experience of the equipment
4. To make student acquire, process, analyse and interpret the data

10. Course Outcomes (COs):

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

1. Distinguish between the crystal structures
2. Calculate various lattice parameters
3. Understand the thermal phenomena in materials
4. associate the theoretical concepts with the experiments

11. List of Experiments

1. To measure the Curie Temperature of a given ferroelectric material.
2. Structural characterization of nanomaterials by XRD- determination of average grain size, lattice parameters, strains etc.
3. Thermal characterization of polymers by DSC/DTA technique.
4. Structural characterization of Glass/Polymer by XRD
5. Thermal characterization of Glasses by DSC/DTA technique.
6. Synthesis of nanoparticles.
7. To study the photodiode characteristics.
8. To find the crystal structure of the nanomaterials
9. Generate a Bravais lattice in Matlab
10. Generate and visualize Wigner Seitz primitive cell in Matlab
11. Plot cubic lattice and a plane with the Miller indices (1, 1, 1).

Note: The list of the experiment given above should be considered as suggestive of the standard and available equipment. The faculty members are authorised to add or delete from this list whenever considered necessary.

12. Book Recommended:

1. Nanoscale Characterization of Surfaces & Interfaces, N John Dinardo, (Weinheim Cambridge: Wiley-VCH, 2000) ISBN: 9783527292479.
2. Vyazovkin, Sergey & Koga, Nobuyoshi & Schick, Christoph. (2018). Handbook of Thermal Analysis and Calorimetry, v.6, Recent Advances, Techniques and Applications., ISBN: 978-0-444-64062-8

Nuclear Physics

1. Name of the Department: Physics

<table>
<tr><td>2. Course Name</td><td>Nuclear Physics</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td>17080315</td><td>3</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">DSE(√)</td><td colspan="2">ASE()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td></td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (√)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical</td></tr>
<tr><td colspan="2">Lectures = 40</td><td colspan="2">Tutorials = 0</td><td colspan="3">Practical = 0</td></tr>
<tr><td colspan="7">8. Brief Syllabus</td></tr>
<tr><td colspan="7">The syllabus is divided into four units i.e. Nuclear Properties, Nuclear Forces, Radioactive decays and Elementary Particles.</td></tr>
<tr><td colspan="7">9.Course objectives:</td></tr>
<tr><td colspan="7">The course develops an understanding of theoretical and experimental approaches for nuclear Properties, forces between nucleons via two nucleon problem. Also this course provide a hand on Radioactive decay and Physics of elementary Particles.</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs):</td></tr>
<tr><td colspan="7">After the successful completion of the course, students will be able to
1. Explain the concepts of Nuclear properties, forces, Radioactive decays and elementary particles in detail.
2. Understand approaches used in research in the field of Experimental and theoretical Nuclear Physics.
3. Use their knowledge in Analytical/Scientific Reasoning in the area of Nuclear Physics.
4. Apply their knowledge in solving problems.</td></tr>
<tr><td colspan="7">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Nuclear Properties</td></tr>
<tr><td colspan="7">Nuclear mass, nuclear radii measurements – scattering and electromagnetic method, Nuclear electric and magnetic moments, Quantum properties of nuclear states, Binding energies, semi empirical mass formula. Liquid drop model, Outlines of Bohr and Wheeler theory.</td></tr>
<tr><td>Unit - 2</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Nuclear Forces</td></tr>
<tr><td colspan="7">Nuclear Forces, Two-nucleon interaction potential, the Deuteron Problem, Ground and excited states of Deuteron, Neutron-proton (n-p) scattering at low energies, Effective range theory in n-p scattering. Coherent and incoherent scattering, tensor forces and the deuteron Problem, proton-proton (p-p) scattering at low energy. Comparison between n-p and p-p scattering.</td></tr>
<tr><td>Unit - 3</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Radio Active Decays</td></tr>
<tr><td colspan="7">Alpha Decay and its Kinematics, Range, Geiger-Nuttal law, Gamow's theory of alpha decay.
Beta decays, Energy relations, Fermi theory of beta decay, Beta transitions, selection rules, Parity violation, Wu-Ambler experiment, helicity of electron and neutrino.
Gamma Decay, Electric and magnetic multipole gamma transitions, selection rules, Internal Conversion process, Transition rates, directional correlation in gamma emission.</td></tr>
<tr><td>Unit - 4</td><td>Number of</td><td colspan="5">Title of the unit: Elementary Particles (10)</td></tr>
</table>

	lectures = 10	

Fundamental Forces, Elementary particles and their quantum numbers (charge, spin, parity, isospin, strangeness, etc.), symmetries and conservation laws. Gellmann-Nishijima formula. Quark model, baryons and mesons. C, P and T invariance. Application of symmetry arguments to particle reactions. Parity non-conservation in weak interaction. Relativistic kinematics.

12. Brief Description of self- learning / E-learning component.

To understand basic concepts in detail, students may get study materials on these links.

1. https://onlinecourses.nptel.ac.in/noc18_ph02
2. https://www.mooc-list.com/tags/nuclear-physics
3. www.nuclearonline.org/Courses.htm
4. https://study.com/directory/category/Physical_Sciences/Physics/Nuclear_Physics.html
5. https://www.class-central.com/tag/nuclear%20physics

13. Books Recommended

1. R. R. Roy and B. P. Nigam, "Nuclear Physics: Theory and Experiment", New Age International Pvt Ltd (1 January 2014). ISBN-978-8122434101
2. D.C. Tayal, "Nuclear Physics", Himalaya Publishing House, 2009 ISBN-13: 978-9350247433
3. W. E. Burcham, "Nuclear Physics : An Introduction", Longman Group Limited, London, 1973. ISBN-978-0582441101
4. R. G. Sachs, "Nuclear Theory", Addison-Wesley Publishing Company, Cambridge, 1955. ISBN-978-0201067002
5. K. S. Krane, "Introductory Nuclear Physics", Wiley India Pvt. Ltd., 2008 ISBN-978-8126517855
6. Introduction to High Energy Physics : D.H. Perkins (Cambridge University Press), 4th ed. 2000. ISBN- 978-0511809040
7. Introduction to Particle Physics : M.P. Khanna (Prentice Hall of India, New Delhi), 2004. ISBN-978-8120312685

1. Name of the Department: Physics						
2. Course Name	**Nuclear Physics Lab**	**L**	**T**		**P**	
3. Course Code	17080316	0	0		4	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**	**AEC ()**	**SEC ()**	**OE ()**
Pre-requisite (if any)		**Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures =		**Tutorials =**	**Hours = 52**			
8. Course Description:						

In this course student will hand on the experiments using weak radioactive sources, G.M. counters, Scintillation Counters, MCA, SCA, DAC and CRO.

9. Course Objectives:

The course aims to provide students with a practical knowledge of the particles identification, basic electronics behind nuclear techniques and radiation and Particle detectors.

10. Course Outcomes (COs):

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

1. Understand and describe the particle Identification.
2. Understand and demonstrate the experimental knowledge in laboratory.
3. Analyse scientific data available from the experiments and explain.
4. Improve their research related skills.

11. List of Experiments

1. To study the variations of count rate with applied voltage and thereby determine the plateau, the operating voltage and the slope of Plateau.
2. Measurement of dead time.
3. To investigate the statistics related to measurements with a Geiger counter – Poisson Distribution
4. To investigate the statistics related to measurements with a Geiger counter- Gaussian Distribution
5. To find the absorption coefficient of given material using G.M. counter and deduce end-point energy of a beta emitter.
6. To study the absorption of Beta particles in different materials.
7. Source strength of a Beta Source.
8. To study the Back scattering of Beta particles.
9. To study Production and attenuation of Bremstrhlung.
10. Measurement of Short Half life.

Note: The list of the experiment given above should be considered as suggestive of the standard and available equipment. The faculty members are authorised to add or delete from this list whenever considered necessary.

12. Books Recommended:

1. Techniques in Nuclear and particle Experiments by W.R. Leo (Springer), 1994. ISBN-978-3540572800
2. Radiation detection and measurement by Glenn F. Knoll (Wiley), 2010. ISBN: 978-0-470-13148-0
3. Introduction to Experimental Particle Physics by Richard Fernow (Cambridge University Press), 2001. ISBN-978-0511622588

1. Name of the Department: Physics						
2. Course Name	Experimental techniques in Nuclear Physics	**L**	**T**		**P**	
3. Course Code	17080319	3	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE(√)**		**ASE()**	
Pre-requisite		**Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()

(if any)						

7. Total Number of Lectures, Tutorials, Practical		
Lectures = 40	**Tutorials = 0**	
8. Brief Syllabus:		
The course is divided into four units i.e. Data interpretation and analysis, radiation and particle detectors, electronics associated with detectors and particle accelerators and facilities in India.		
9. Course Objectives:		
The aim and objective of the course is to make a ground for students to work in experimental research in the field of Nuclear Physics. In this course students are given exposure to theoretical and experimental aspects of different equipment and methods used in the experimentation.		
10. Course Outcomes (COs):		
After the successful completion of the course, students will be able to 1. Understand and explain various experimental techniques used in Nuclear Physics research. 2. Use the knowledge of detectors and associated electronics. 3. Understand the developments and challenges in detection systems and particle accelerators. 4. Understand the Analytical and Scientific Reasoning in area of experimental Nuclear Physics. 5. Know the particle accelerators and facilities available in India.		
11. Unit wise detailed content		
Unit-1	**Number of lectures = 10**	**Title of the unit: Data Interpretation and analysis**
Precision and accuracy, error analysis, Statistical treatment of experimental data. Least squares fitting of linear and nonlinear functions, chi square test, Binomial, Poisson and Gaussian distributions, Lorentzian distributions. Review on Detection of radiations: Interaction of gamma-rays, neutrons, electrons and heavy charged articles with matter, Relativistic particle interaction.		
Unit - 2	**Number of lectures = 10**	**Title of the unit: Radiation and Particle detectors**
General properties of Radiation detectors: energy resolution, detection efficiency and dead time. Statistics and treatment of experimental data. Gas-filled detectors: Proportional counters, G.M. Counter, position-sensitive proportional counters, Multiwire proportional chambers, Drift chamber, Time projection chamber. Organic and inorganic scintillators and their characteristics, description of electron and gamma ray spectrum from detector, Cherenkov detector. Semiconductor detectors in X- and gamma-ray spectroscopy, Ge, Si(Li) and SDD detectors, Compton-suppressed Ge detectors, Semiconductor detectors for charged particle spectroscopy and particle identification, Silicon strip detectors, General Background and detector shielding.		
Unit - 3	**Number of lectures = 10**	**Title of the unit: Electronics associated with detectors**
Electronic shielding and grounding, Measurement and control, Signal conditioning and recovery. Electronics for pulse signal processing, preamplifiers (voltage and charge-sensitive configurations), Linear amplifiers, CR-$(RC)_n$ and delay-line pulse shaping, pole-zero cancellation, baseline shift and restoration, overload recovery and pileup, Impedance matching, single-channel and multichannel analysers		
Unit - 4	**Number of lectures = 10**	**Title of the unit: Particle Accelerators and facilities in India**

Van-de Graff generator, Cyclotron, Linear accelerator, Pelletron, Synchrotron, production of radioactive ion beams. Detector systems for heavy-ion reactions: Large gamma and charge particle detector arrays, multiplicity filters, electron spectrometer, heavy-ion reaction analyzers, nuclear lifetime measurements (DSAM and RDM techniques).
12. Brief Description of self-learning / E-learning component:
1. To understand basic concepts in detail, students may get study materials on following links. 2. https://onlinecourses.nptel.ac.in/noc18_ph02 3. https://www.mooc-list.com/tags/nuclear-physics 4. www.nuclearonline.org/Courses.htm 5. https://study.com/directory/category/Physical_Sciences/Physics/Nuclear_Physics.html 6. https://www.class-central.com/tag/nuclear%20physics_
13. Books Recommended
1. Techniques in Nuclear and particle Experiments by W.R. Leo (Springer), 1994. ISBN-978-3540572800 2. Radiation detection and measurement by Glenn F. Knoll (Wiley), 2010. ISBN: 978-0-470-13148-0 3. Introduction to Experimental Particle Physics by Richard Fernow (Cambridge University Press), 2001. ISBN-978-0511622588 4. Detectors for particle radiation by Konrad Kleinknecht(Cambridge University Press), 1999. ISBN: 9780521648547

1. Name of the Department: Physics						
2. Course Name	**Experimental techniques in Nuclear Physics Lab**	**L**	**T**		**P**	
3. Course Code	17080320	0	0		4	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**	**AEC ()**	**SEC ()**	**OE ()**

Pre-requisite (if any)		**Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical

Lectures =	**Tutorials =**	**Practical = 52**

8. Course Description:

In this course student will hand on the experiments using weak radioactive sources, G.M. counters, Scintillation Counters, MCA, SCA, DAC and CRO.

9. Course Objectives:

The course aims to provide students with a practical knowledge of the particles identification, basic electronics behind nuclear techniques and radiation and Particle detectors.

10. Course Outcomes (COs):

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

1. Understand and describe the particle Identification.
2. Understand and demonstrate the experimental knowledge in laboratory.
3. Analyse scientific data available from the experiments and explain.
4. Improve their research related skills.

11. List of Experiments

1. To determine the plateau, and find the operating voltage of GM tube
2. Calibration of Scintillation Spectrometer.
3. Pulse-Height Analysis of Gamma Ray Spectra.
4. To trace the signal of particle detection in a scintillator using CRO.
5. Least square fitting of a straight line.
6. To determine the range of Alpha-particles in air at different pressures and energy loss in thin foils.
7. To determine strength of alpha particles using Solid state nuclear track detector (SSNTD).
8. Study of Compton Scattering Effect.
9. To study p-p interaction and find the cross-section of a reaction using a bubble chamber.
10. To study n-p interaction and find the cross-section using a bubble chamber.

Note: The list of the experiment given above should be considered as suggestive of the standard and available equipment. The faculty members are authorised to add or delete from this list whenever considered necessary.

12. Books Recommended:

1. Techniques in Nuclear and particle Experiments by W.R. Leo (Springer), 1994. ISBN-978-3540572800
2. Radiation detection and measurement by Glenn F. Knoll (Wiley), 2010. ISBN: 978-0-470-13148-0
3. Introduction to Experimental Particle Physics by Richard Fernow (Cambridge University Press), 2001. ISBN-978-0511622588

1. Name of the Department: Physics

2. Course Name	Advanced Nuclear Physics: Structure and Reactions	**L**	**T**	**P**
3. Course Code	17080317	3	0	0

<table>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">DSE(√)</td><td colspan="2">ASE()</td></tr>
<tr><td>Pre-requisite (if any)</td><td></td><td>Frequency (use tick marks)</td><td>Even ()</td><td>Odd (√)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical</td></tr>
<tr><td colspan="2">Lectures = 40</td><td>Tutorials = 0</td><td colspan="4"></td></tr>
<tr><td colspan="7">8. Brief Syllabus:</td></tr>
<tr><td colspan="7">The course is divided into four units i.e. Nuclear shell model, collective model, Advanced Nuclear Structure, nuclear reactions.</td></tr>
<tr><td colspan="7">9.Course objectives:</td></tr>
<tr><td colspan="7">The course aims to provide students an understanding of advancements in Nuclear Physics research. The course explains the development of nuclear structure and nuclear reactions using theoretical approaches and experimental data.</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs):</td></tr>
<tr><td colspan="7">After the successful completion of the course, student will be able to
1. Explain comprehensively about the various nuclear models and nuclear reactions.
2. Understand experimental and theoretical approaches used in research in the field of Nuclear Physics.
3. Use their knowledge in Analytical/Scientific Reasoning in the area of Nuclear Physics.
4. Understand the present scenario in the field of Nuclear Physics.</td></tr>
<tr><td colspan="7">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Nuclear Shell Model</td></tr>
<tr><td colspan="7">Evidence for nuclear shell structure, Extreme single particle model, Shell model predictions. Single-particle model, nuclear isomerism, Magnetic moment-Schmidt lines, electric quadrupole moment, Configuration mixing, Independent particle model, L-S coupling and J-J coupling.</td></tr>
<tr><td>Unit - 2</td><td>Number of lectures = 12</td><td colspan="5">Title of the unit: Collective Model</td></tr>
<tr><td colspan="7">Rotation-D matrices and properties, Collective modes of motion, nuclear vibrations, iso-scalar vibrations, Giant resonance, Parameterization of nuclear surface, Derivation of the collective Hamiltonian, Deformed rotational nuclei, rotational energy spectra for even-even nuclei and odd-A nuclei, Electric quadrupole moment, magnetic dipole moment, Energy spectrum with coupling of vibration and rotational motion.</td></tr>
<tr><td>Unit - 3</td><td>Number of lectures = 8</td><td colspan="5">Title of the unit: Advanced Nuclear Structure</td></tr>
<tr><td colspan="7">Harmonic anisotropic oscillator, Nilsson model, Rotational motion at very high spins, Cranking shell model, Kinematics and dynamic moment of inertia, Back-bending phenomenon.
Brief review - Nuclear Physics at extremes of stability.</td></tr>
<tr><td>Unit - 4</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Nuclear Reaction</td></tr>
<tr><td colspan="7">Nuclear Reaction Cross sections, Breit-Wigner dispersion formula, the Compound nucleus, Continuum theory of cross section, Statistical theory of Nuclear Reaction. Optical model for nuclear reactions at low energies, comparison with experiments. Direct Reactions - Kinematics of stripping and pick-up reactions, theory of stripping and pick-up reactions.</td></tr>
</table>

11. Brief Description of self-learning / E-learning component:
To understand basic concepts in detail, students may get study materials on following links. 1. https://onlinecourses.nptel.ac.in/noc18_ph02 2. https://www.mooc-list.com/tags/nuclear-physics 3. www.nuclearonline.org/Courses.htm 4. https://study.com/directory/category/Physical_Sciences/Physics/Nuclear_Physics.html 5. https://www.class-central.com/tag/nuclear%20physics

13. Books Recommended
1. R. R. Roy and B. P. Nigam, "Nuclear Physics: Theory and Experiment", New Age International Pvt Ltd (1 January 2014). ISBN-978-8122434101. 2. M. K. Pal, "Theory of Nuclear Structure", Affiliated East-West Press, New Delhi. ISBN-978-8185336817. 3. Basic Ideas and Concepts in Nuclear Physics: K. Heyde, (Overseas Press India) (2005). ISBN-978-0750309806. 4. Elementary theory of Angular momentum: M.E. Rose (Dover edition) (1995). ISBN-978-0486684802. 5. Nuclear Physics: Experimental and Theoretical: H. S. Hans, New Age International Pvt Ltd (1 January 2019) ISBN-978-8122431414

1. Name of the Department: Physics				
2. Course Name	**Advanced Nuclear Physics Laboratory**	**L**	**T**	**P**
3. Course	17080318	0	0	4

Code						
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**	**AEC ()**	**SEC ()**	**OE ()**
Pre-requisite (if any)		**Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical

Lectures =	**Tutorials =**	**Practical = 52**

8. Course Description:

In this course student will hand on the experiments using weak radioactive sources, G.M. counters, Scintillation Counters, MCA, SCA, DAC and CRO.

9. Course Objectives:

The course aims to provide students with a practical knowledge of the particles identification, basic electronics behind nuclear techniques and Radiation and particle detector.

10. Course Outcomes (COs):

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

1. Understand and describe the particle Identification.
2. Understand and demonstrate the experimental knowledge in laboratory.
3. Analyse scientific data available from the experiments and explain.
4. Improve their research related skills.

11. List of Experiments

1. To find the operating voltage of GM Tube
2. Window thickness of a G.M. Tube.
3. To distinguish between beta and gamma radiation using GM Tube
4. To estimate the efficiency for a gamma Source.
5. To estimate the efficiency for Beta Source.
6. To Study the inverse square Law.
7. To determine the range of beta particle and maximum energy using Half thickness method.
8. To study the alpha spectrum from natural sources Th and U.
9. To determine the gamma-ray absorption coefficient for different elements.
10. To calibrate the given gamma-ray spectrometer and determine its energy resolution.

Note: The list of the experiment given above should be considered as suggestive of the standard and available equipment. The faculty members are authorised to add or delete from this list whenever considered necessary.

12. Books Recommended:

1. Techniques in Nuclear and particle Experiments by W.R. Leo (Springer), 1994. ISBN-978-3540572800
2. Radiation detection and measurement by Glenn F. Knoll (Wiley), 2010. ISBN: 978-0-470-13148-0
3. Introduction to Experimental Particle Physics by Richard Fernow (Cambridge University Press), 2001. ISBN-978-0511622588

Semester-IV

Students either have to complete a project work of six months (in-house/ at an industrial / scientific organization) or they may opt the four courses to be completed out of the below given list except their specialized subject:

<table>
<tr><td colspan="7">1. Name of the Department: Physics</td></tr>
<tr><td>2. Course Name</td><td>Electronics</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td>17080402</td><td>4</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">DSE (√)</td><td colspan="2">SEC ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Physics at graduation level</td><td>6. Frequency (use tick marks)</td><td>Even (√)</td><td>Odd ()</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical</td></tr>
<tr><td colspan="2">Lectures = 52</td><td>Tutorials = 0</td><td colspan="4">Practical = 0</td></tr>
</table>

8. Course Description:

The course is intended to provide an understanding of the semiconductor devices used in the current semiconductor industry. It caters to undergraduate and graduate students with a diverse background in Materials Science, and Physics. The course provides the students with the basic physics behind semiconductor materials, types of semiconductors, and the reason for the dominance of silicon in the electronics industry. The course also covers the basics of devices with emphasis on their electronic characteristics. Optical devices like LEDs, lasers, solar cells, and their properties will also be explained.

9. Course Objectives:

1. To study the basics of electronic components
2. To study the basic concept and characteristics of electronic devices and circuits.
3. To observe the characteristics of optical devices like LED, lasers and Solar cells
4. To get familiar with the different number systems and logic gates
5. To study the basics of microprocessor

10. Course Outcomes (Cos):

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

1. Apply the concept of semiconductor physics.
2. Apply the concepts of basic electronic devices to design various electronic circuits.
3. Understand operation of diodes, transistors in order to design basic and advanced circuits.
4. Analyze electronic circuits designed using operational amplifiers (Op-Amp).
5. Understand the working principle and uses of microprocessors.

11. Unit wise detailed content

Unit-1	**Number of lectures = 14**	**Title of the unit: Basic Semiconductor Devices**

P-N junction diode, Capacitance of p-n junctions, switching diodes, Clippers & Clampers, Photoconductors, photodiode, light emitting diodes and liquid crystal display, Junction Field Effect Transistor (JFET) : Basic structure & Operation, pinch off voltage, Single ended geometry of JFET, Volt Ampere characteristic, Transfer Characteristics, JFET as Switch and Amplifier. MOSFET: Enhancement MOSFET, Threshold Voltage, Depletion MOSFET, comparison of p & n Channel FET, SCR, 4-layer pnpn devices, Tunnel diode

Unit – 2	**Number of lectures = 14**	**Title of the unit: Digital Electronics**

Various Number system and their arithmetic: binary number system, 2's compliment, Octal number system, hexadecimal number system, BCD codes, Excess-3 codes, Gray codes, Octal codes, Hexadecimal codes and ASCII codes: Digital (binary) operation of a system, Logic system, the OR gate, the AND gate, the NOT gate, the exclusive OR gate, De Morgan's laws, the NAND and NOR diode- transistor gates, transistor-transistor logic (TTL) gates output stages, Digital MOSFET circuits, complementary MOS (CMOS) logic gates, Boolean Algebra, comparison of logic families, Karnaugh-map (K-map) up to four variables and its applications.		
Unit – 3	**Number of lectures = 12**	**Title of the unit: Operational Amplifier**
Differential Amplifier, Inverting & non-inverting Amplifiers, Negative and Positive Feedback. Band width,Voltage follower. CMRR, DC, AC, Summing, Scaling & Instrumentation Amplifier, Integrator & Differentiator, Comparator, Oscillator principal and Types, Frequency response and Frequency stability, Phase shift Oscillator		
Unit – 4	**Number of lectures = 12**	**Title of the unit: Micro-processor**
Microcomputer systems and Hardware., Microprocessor architecture and Microprocessor system, Instruction and timing diagram, Introduction to 8085 basic instructions, Arithmetic operation, logic operation, branch operation, 16 bit arithmetic instructions., Arithmetic operation related to memory, Rotate and compare instructions, Stack and subroutines, programming of 8085 using instructions, Introduction to Microcontroller		
12. Brief Description of self-learning / E-learning component		
For understanding the basic concepts in detail, students may get the study materials from these E-learning links https://ocw.mit.edu/courses/physics/ https://nptel.ac.in/courses/117107094/ https://www.youtube.com/watch?v=CeD2L6KbtVM		
13. Books Recommended		
1. J. Millman and C. C. Halkies, Integrated Electronics. Tata McGraw-Hill, ISBN: 978-0-07-462245-2. 2. R. P. Jain. Modern Digital Electronics, Tata McGraw Hills, ISBN: 9780070669116 3. Malvino and Leach, Digital Electronics, ISBN- 978-0-07-014170-4 4. S. M. Sze, Semiconductor Devices: Physics and Technology, ISBN-13: 978-8126516810 5. Ramakanth A. Gayakwad, Op-Amps & Linear Integrated Circuits. 2^{nd} ed, ISBN-13: 978-8120320581 6. A.P. Malvino and Donald, Principal and Application in Electronics. Tata McGraw-Hill, ISBN : 0070141703 7. J. D. Rayder, Fundamental of electronics, ISBN-13: 978-8120300828		

<table>
<tr><td colspan="7">1. Name of the Department: Physics</td></tr>
<tr><td>2. Course Name</td><td>Electronics Lab</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td>17080403</td><td>0</td><td colspan="2">0</td><td colspan="2">2</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">DSE (√)</td><td colspan="2">SEC ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td></td><td>6. Frequency (use tick marks)</td><td>Even (√)</td><td>Odd ()</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical</td></tr>
<tr><td colspan="2">Lectures = 0</td><td colspan="2">Tutorials = 0</td><td colspan="3">Practical = 26</td></tr>
</table>

8. Course Description:

In this course students will gain practical knowledge about various semiconductor and optoelectronic deviceslike JFET, MOSFET, LEDetc and use of op amp for different arithmetic operations.

9. Course Objectives:

To study the characteristics of JFET, MOSFET, Solar cell

To use op amp for different arithmetic operations, square, ramp generator and Wein bridge oscillator

10. Course Outcomes (Cos):

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

Correlate the theoretical concepts and identify its practical applications through experiment procedure and results.

11. List of Experiments

1. To study the characteristics of Junction Field Effect Transistor.
2. To study the characteristics of Metal Oxide Semiconductor Field Effect Transistor
3. To study the characteristics of SCR and its application as a switching device.
4. To use Op-Amp for different Arithmetic Operations.
5. To study the characteristics of UJT.
6. To study the characteristics of a solar cell and calculate its fill factor.
7. To design an (i) inverting amplifier and (ii) non-inverting amplifier, of a given gain using operational amplifier.
8. To use Op-Amp as Full Wave Rectifier.
9. To study the characteristics of optoelectronics Devices (LED, photo-detector).
10. To design combinational Logic Circuits using logic gates.

Note: The list of the experiment given above should be considered as suggestive of the standard and available equipment. The faculty members are authorised to add or delete from this list whenever considered necessary.

12. Book Recommended:

3. R. A. Dunlup. Experimental Physics: Modern Methods. New Delhi: Oxford University Press, ISBN- 0195049497
4. B. K. Jones. Electronics for Experimentation and Research. Prentice-Hall, ISBN 13:

9780132507547

1. Name of the Department: Physics						
2. **Course Name**	**Solid State Physics**	**L**	**T**		**P**	
3. Course Code	17080404	4	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**		**SEC ()**	
5. Pre-requisite (if any)	Physics at graduation level	**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical		
Lectures = 40	**Tutorials = 0**	**Practical = 0**

8. Course Description:

This course will deepen your understanding of the different types of crystal structures, lattice dynamics and band structure of the solids.

9. Course Objectives:

1. To study the basics of crystallography
2. To study the basic of origin of band gap in different types of solids.
3. To analyze the electrical and thermal properties of metals.

10. Course Outcomes (Cos):

After successful completion of the course, students will

1. have a basic knowledge of crystal systems and spatial symmetries
2. understand the concept of reciprocal space and be able to use it as a tool to know the significance of Brillouin zones
3. be able to calculate thermal and electrical properties in the free-electron model
4. be able to outline the importance of solid-state physics in the modern society

11. Unit wise detailed content

Unit-1	**Number of lectures = 11**	**Title of the unit: Crystal Structure**

Bravais lattice, Primitive vectors, Primitive, conventional and Wigner-Seitz unit cells, Crystal structures and lattices with basis, Lattice planes and Miller indices, Simple crystal structures- Sodium chloride, Cesium chloride, Diamond, and Zinc-blende structures, Determination of crystal structure by diffraction, Reciprocal lattice and Brillouin zones (examples of sc, bcc and fcc lattices), Bragg and Laue formulations of X-ray diffraction by a crystal and their equivalence, Laue equations, Ewald construction, atomic structure factors, Experimental methods of structure analysis: Types of probe beam, the Laue, rotating crystal and powder methods.

Unit – 2	**Number of lectures = 11**	**Title of the unit: Lattice dynamics and thermal properties**

Classical theory of lattice vibration (harmonic approximation), Vibrations of crystals with monatomic basis-Dispersion relation, First Brillouin zone, Group velocity, Two atoms per primitive basis-acoustical and optical modes; Quantization of lattice vibration: Phonons, Phonon momentum, Inelastic scattering of neutrons by phonons; Thermal properties: Lattice (phonon) heat capacity, Normal modes, Density of states in one and three dimensions, Models of Debye and Einstein.

Unit – 3	**Number of lectures = 8**	**Title of the unit: Free electron gas**

Free electron gas model in three dimensions: Density of states, Fermi energy, Effect of temperature, Heat capacity of the electron gas, Experimental heat capacity of metals, Thermal effective mass, Electrical conductivity and Ohm's law, Hall effect; Failure of the free electron gas model		
Unit – 4	**Number of lectures = 10**	**Title of the unit: Band Theory**
Periodic potential and Bloch's theorem, Kronig-Penney model, Wave equation of electron in a periodic potential, Solution of the central equation, Approximate solution near a zone boundary, Periodic, extended and reduced zone schemes of energy band representation, Number of orbitals in an energy band, Classification into metals, semiconductors and insulators.		
12.Brief Description of self-learning / E-learning component		
For understanding the basic concepts in detail, students may get the study materials from these E-learning links https://ocw.mit.edu/courses/physics/ https://nptel.ac.in/courses/115105099/ https://nptel.ac.in/courses/115104109/		
13.Books Recommended		
1. Introduction to Solid State Physics, Charles Kittel, John Wiley and Sons, ISBN: 978-8126535187 2. Solid State Physics, Neil W. Ashcroft and N. David Mermin, Holt, Rinehart and Winston, ISBN: 978-0030839931 3. Applied Solid State Physics, Rajnikant, Wiley India, ISBN: 9788126522835 4. Solid State Physics, S O Pillai, New Age International Publishers, ISBN: 978-9386070920 5. Elements of Solid State Physics, J P Srivastava, PHI Learning Private Limited, ISBN: 978-81-203-5066-3		

<table>
<tr><td colspan="7">1. Name of the Department: Physics</td></tr>
<tr><td>2. Course Name</td><td>Solid State Physics Lab</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td>17080405</td><td>0</td><td colspan="2">0</td><td colspan="2">2</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">DSE (√)</td><td colspan="2">SEC ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td></td><td>6. Frequency (use tick marks)</td><td>Even (√)</td><td>Odd ()</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical</td></tr>
<tr><td colspan="2">Lectures = 0</td><td colspan="2">Tutorials = 0</td><td colspan="3">Practical = 26</td></tr>
<tr><td colspan="7">8. Course Description:</td></tr>
<tr><td colspan="7">In this course students will gain practical knowledge about lattice dynamics, band gap and basic concepts of semiconductor devices</td></tr>
<tr><td colspan="7">9. Course Objectives:</td></tr>
<tr><td colspan="7">The major objective of this course is to make students understand the basic concepts of solid state physics through standard set of experiments. While performing these experiments students must correlate them with the corresponding theory</td></tr>
<tr><td colspan="7">10. Course Outcomes (Cos):</td></tr>
<tr><td colspan="7">After successful completion of the course, students will be able to
1. Distinguish between the type of semiconductors and find their band gap
2. to understand the lattice dynamics
3. correlate the theoretical concepts with the experiments</td></tr>
<tr><td colspan="7">11. List of Experiments</td></tr>
<tr><td colspan="7">1. To study Hall effect in semiconductor to determine Hall voltage, concentration of charge carriers and the type of semiconductor etc.
2. To measure the band gap of Germanium using four probe method.
3. Study of dispersion relation for the mono-atomic lattice – comparison with theory.
4. Determination of cut-off frequency of the mono atomic lattice
5. Study of the dispersion relation for the di-atomic lattice – acoustical mode and optical mode energy gap. Comparison with theory.
6. To determine the value of e/m by Thomson’s method
7. To determine band gap using van der Paw technique
8. To determine the value of e/m by helical method
9. To study conductivity of thin film by four probe method.
10. Two probe method for resistivity measurement.
Note: The list of the experiment given above should be considered as suggestive of the standard and available equipment. The faculty members are authorised to add or delete from this list whenever considered necessary.</td></tr>
<tr><td colspan="7">12. Book Recommended:</td></tr>
<tr><td colspan="7">1. Harnam Singh and P S Hemne, Practical Physics, S Chand, ISBN: 9788121904698
2. R. A. Dunlup. Experimental Physics: Modern Methods. New Delhi: Oxford University Press, 978-0195049497</td></tr>
</table>

<table>
<tr><td colspan="9">1. Name of the Department: Physics</td></tr>
<tr><td>2. Course Name</td><td>Introductory Nuclear Physics</td><td colspan="2">L</td><td colspan="3">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td>17080406</td><td colspan="2">4</td><td colspan="3">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td colspan="2">Core ()</td><td colspan="3">DSE(√)</td><td colspan="2">ASE()</td></tr>
<tr><td>1. Pre-requisite (if any)</td><td></td><td colspan="2">2. Frequency (use tick marks)</td><td>Even (√)</td><td colspan="2">Odd ()</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="9">7. Total Number of Lectures, Tutorials, Practical</td></tr>
<tr><td colspan="2">Lectures = 52</td><td colspan="3">Tutorials = 0</td><td colspan="4">Practical = 0</td></tr>
<tr><td colspan="9">8. Brief Syllabus</td></tr>
<tr><td colspan="9">The syllabus is divided into four units i.e. Nuclear Properties, Nuclear Forces, Nuclear Models and Nuclear reactions.</td></tr>
<tr><td colspan="9">9.Course objectives:</td></tr>
<tr><td colspan="9">The course develops an understanding of theoretical and experimental approaches for nuclear Properties, forces between nucleons via two nucleon problem, development of structure of the nucleus and various models for nuclear reactions.</td></tr>
<tr><td colspan="9">10. Course Outcomes (Cos):</td></tr>
<tr><td colspan="9">After the successful completion of the course, students will be able to
1. Understand and Explain the concepts of Nuclear properties, forces, models and reactions in detail.
2. Understand approaches used in research in the field of Experimental and theoretical Nuclear Physics.
3. Use their knowledge in Analytical/Scientific Reasoning in area of Nuclear Physics.
4. Apply their knowledge in solving problems.</td></tr>
<tr><td colspan="9">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td colspan="2">Number of lectures = 12</td><td colspan="6">Title of the unit: Nuclear Properties</td></tr>
<tr><td colspan="9">Nuclear mass, nuclear radii measurements – scattering and electromagnetic method, Nuclear electric and magnetic moments, Quantum properties of nuclear states, Binding energies, semi empirical mass formula. Liquid drop model, Outlines of Bohr and Wheeler theory.</td></tr>
<tr><td>Unit – 2</td><td colspan="2">Number of lectures = 14</td><td colspan="6">Title of the unit: Nuclear Forces</td></tr>
</table>

Nuclear Forces, The Deuteron Problem, Ground and excited states of Deuteron, Neutron-proton (n-p) scattering at low energies, Scattering length, Spin dependence, singlet state, Effective range theory in n-p scattering. Coherent and incoherent scattering, tensor forces and the deuteron Problem, proton-proton (p-p) scattering at low energy. Comparison between n-p and p-p scattering.		
Unit – 3	**Number of lectures = 14**	**Title of the unit: Nuclear Models**
Evidence for nuclear shell structure, Nuclear Shell Model, Extreme single particle model, Square well potential, Harmonic oscillator potential, spin orbit coupling, Shell model predictions. Nuclear isomerism, Magnetic moment-Schmidt lines, electric quadrupole moment, Configuration mixing, Single particle model and Independent particle model, Nuclear Collective model: Collective modes of motion, Rotational energy spectra for even-even nuclei and odd-A nuclei, Energy spectrum with coupling of vibration and rotational motion.		
Unit – 4	**Number of lectures = 12**	**Nuclear Reactions**
Breit-Wigner dispersion formula, the Compound nucleus, Continuum theory of cross section, Statistical theory of Nuclear Reaction. Optical model for nuclear reactions at low energies, Direct Reactions – Kinematics of stripping and pick-up reactions, theory of stripping and pick-up reactions.		
12. Brief Description of self- learning / E-learning component.		
To understand basic concepts in detail, students may get study materials on these links. 1. https://onlinecourses.nptel.ac.in/noc18_ph02 2. https://www.mooc-list.com/tags/nuclear-physics 3. www.nuclearonline.org/Courses.htm 4. https://study.com/directory/category/Physical_Sciences/Physics/Nuclear_Physics.html 5. https://www.class-central.com/tag/nuclear%20physics		
13. Books Recommended		
1. R. R. Roy and B. P. Nigam, “Nuclear Physics: Theory and Experiment”, New Age International Pvt Ltd (1 January 2014). ISBN-978-8122434101 2. D.C. Tayal, “Nuclear Physics”, Himalaya Publishing House, 2009 ISBN-13: 978-9350247433 3. M. K. Pal, “Theory of Nuclear Structure”, Affiliated East-West Press, New Delhi. ISBN-978-8185336817. 4. Basic Ideas and Concepts in Nuclear Physics: K. Heyde, (Overseas Press India) (2005). ISBN-978-0750309806. 5. K. S. Krane, “Introductory Nuclear Physics”, Wiley India Pvt. Ltd., 2008 ISBN-978-8126517855		

<table>
<tr><td colspan="7">1. Name of the Department: Physics</td></tr>
<tr><td>2. Course Name</td><td>Introductory Nuclear Physics Laboratory</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td>17080407</td><td>0</td><td colspan="2">0</td><td colspan="2">2</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td>DSE (√)</td><td>AEC ()</td><td>SEC ()</td><td>OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td></td><td>6. Frequency (use tick marks)</td><td>Even (√)</td><td>Odd ()</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical</td></tr>
<tr><td colspan="2">Lectures =</td><td colspan="2">Tutorials =</td><td colspan="3">Hours = 26</td></tr>
<tr><td colspan="7">8. Course Description:</td></tr>
<tr><td colspan="7">In this course student will hand on the experiments using weak radioactive sources, G.M. counters, Scintillation Counters, MCA, SCA, DAC and CRO.</td></tr>
<tr><td colspan="7">9. Course Objectives:</td></tr>
<tr><td colspan="7">The course aims to provide students with a practical knowledge of the particles identification, basic electronics behind nuclear techniques and radiation and Particle detectors.</td></tr>
<tr><td colspan="7">10. Course Outcomes (Cos):</td></tr>
<tr><td colspan="7">After the successful completion of the course, students will be able to
1. Understand and describe the particle Identification.
2. Understand and demonstrate the experimental knowledge in laboratory.
3. Analyse scientific data available from the experiments and explain.
4. Improve their research related skills.</td></tr>
<tr><td colspan="7">11. List of Experiments</td></tr>
<tr><td colspan="7">1. To study the variations of count rate with applied voltage and thereby determine the plateau, the operating voltage and the slope of Plateau.
2. Measurement of dead time.
3. To investigate the statistics related to measurements with a Geiger counter – Poisson Distribution
4. To investigate the statistics related to measurements with a Geiger counter- Gaussian Distribution
5. To find the absorption coefficient of given material using G.M. counter and deduce end-point energy of a beta emitter.
6. Source strength of a Beta Source.
7. Measurement of Short Half life.</td></tr>
</table>

8. Calibration of Scintillation Spectrometer.
9. Pulse-Height Analysis of Gamma Ray Spectra.
10. Least square fitting of a straight line.

Note: The list of the experiment given above should be considered as suggestive of the standard and available equipment. The faculty members are uthorized to add or delete from this list whenever considered necessary.

12. Books Recommended:

1. Techniques in Nuclear and particle Experiments by W.R. Leo (Springer), 1994. ISBN-978-3540572800
2. Radiation detection and measurement by Glenn F. Knoll (Wiley), 2010. ISBN: 978-0-470-13148-0
3. Introduction to Experimental Particle Physics by Richard Fernow (Cambridge University Press), 2001. ISBN-978-0511622588

<table>
<tr><td colspan="7">1. Name of the Department: Physics</td></tr>
<tr><td>2. Course Name</td><td>Advanced Applied Physics</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td>17080408</td><td>4</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">DSE(√)</td><td colspan="2">OE()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td></td><td>6. Frequency (use tick marks)</td><td>Even (√)</td><td>Odd ()</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical</td></tr>
<tr><td colspan="2">Lectures = 52</td><td>Tutorials = 0</td><td colspan="4">Practical = 0</td></tr>
<tr><td colspan="7">8. Brief Syllabus:</td></tr>
<tr><td colspan="7">This course will give an introduction to transducer devices, applications of transducer, sensors, detectors, photonics, energy processing, energy storage and conversion systems.</td></tr>
<tr><td colspan="7">9. Learning objectives:</td></tr>
<tr><td colspan="7">The aim of this course is to
1. convey knowledge of conceptual physics and its applications including transducers
2. understand the different types of sensors and its applications
3. learn the fundamentals of photonics and its applications in Lasers.
4. understand the energy storage devices and conversion systems.</td></tr>
<tr><td colspan="7">10. Course Outcomes (Cos):</td></tr>
<tr><td colspan="7">After the successful completion of the course, students would be able to
1. understand the different types of transducers.
2. understand the construction and working principle of different types of sensors.
3. understand the concepts of photonics and get knowledge of the latest developments in Lasers and their applications.
4. analyze the concept of alternate energy storage devices.</td></tr>
<tr><td colspan="7">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td>Number of lectures = 13</td><td colspan="5">Title of the unit: Transducers</td></tr>
<tr><td colspan="7">Fundamentals of transducer, classifications and general characteristics; displacement transducers, strain gauges, pressure and force transducers, torque transducers, flow transducers, transducers for biomedical applications. Microelectromechanical systems (MEMS), microfabrication and</td></tr>
</table>

micromachining, advanced lithography techniques, diffusion & ion implantation, and high aspect ratio processes.		
Unit – 2	**Number of lectures = 12**	**Title of the unit: Sensors**
Resistive, capacitive, inductive, electromagnetic, thermoelectric, piezoelectric, piezoresistive, photosensitive and electrochemical sensors, toxic gas monitoring, thermal conductivity analyzers, colorimetric determination, sorption type dosimeters, non-dispersive infrared and ultraviolet sensors flame ionisation detector.		
Unit – 3	**Number of lectures = 13**	**Title of the unit: Introduction to photonics**
Science of light – evolution, ray/wave/statistical/quantum optics, wave phenomena – interference, diffraction, statistical properties of light – coherence, photons, photon properties – energy, flux, statistics, interaction of photons with atoms, light amplification, laser fundamentals, semiconductor junction characteristics, semiconductor light sources, semiconductor light detectors.		
Unit – 4	**Number of lectures = 14**	**Title of the unit: Alternate Energy Storage and Harvesting**
Electrochemical energy storage devices – EMF, reversible and irreversible cells, free energy, thermodynamic calculation of the capacity of a battery, calculations of energy and power density of cells, types of batteries, factors affecting battery capacity, voltage and current level, types of discharge, applications of lithium ion batteries in electronic devices, and electric vehicle, basics of solar energy, brief history of solar energy utilization, various approaches of utilizing solar energy, formation of solar cell and its equation, fill factor and maximum power, silicon solar cell, tandem solar cell, dye sensitized solar cell; organic solar cell.		
Brief Description of self-learning / E-learning component:		
https://nptel.ac.in/courses/108/108/108108147/ https://nptel.ac.in/courses/108/106/108106135/ https://www.youtube.com/watch?v=G6MIQlIIozg&list=PLLy_2iUCG87BMH9aXArALEv_eH_f63kQu https://onlinecourses.nptel.ac.in/noc19_ee41/preview		
12. Books Recommended		
1. Yariv, Photonics: Optical Electronics in Modern Communications, Oxford University Press, ISBN: 978-0195687057. 2. Patranabis D, Sensors and Transducers, Prentice Hall India Learning Private Limited, ISBN: 978-8120321984 3. Fraden Jacob , Handbook of Modern Sensors: Physics, Designs, and Applications, Springer Nature (SIE), ISBN: 978-8132230984 4. Jacob Fraden, Handbook of Modern Sensors Hardcover, Springer Nature, ISBN: 978-3319193021		

1. Name of the Department: Physics							
2. **Course Name**	**Advanced Applied Physics Lab**	**L**	**T**		**P**		
3. Course Code	17080409	0	0		2		
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**	**AEC ()**	**SEC ()**	**OE ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()	
7. Total Number of Lectures, Tutorials, Practical							
Lectures = 0		**Tutorials = 0**		**Practical = 26**			
8. Course Description:							
Experiments include the characteristics of transducer devices, applications of laser and solar cell.							
9. Course Objectives:							
To understand the characteristics curves for transducer devices, sensors, solar cell and applications of laser.							
10. Course Outcomes (Cos):							
After successful completion of the course, students will be able to 1. Understand the characteristic curve of transducer devices. 2. Understand the operation and applications of laser. 3. Understand the operation of solar cell.							
11. List of Experiments							
1. To verify the characteristics of strain gauge. 2. To verify the characteristics of RTD (Resistance Temperature Detector) using wheat stone bridge. 3. To study the characteristics of piezoelectric transducer. 4. To plot the area characteristics and spectral characteristics of a solar cell. 5. To measure the peak power and beam divergence of a given laser beam. 6. Using He-Ne laser to measure width of a narrow slit. 7. Using He-Ne laser to measure diameter of a thin wire. 8. To study the characteristics of a semiconductor laser. 9. To study the characteristics of a solar cell (illumination Characteristics, Current Voltage							

Characteristics, Power Load Characteristics). 10. To count the number of slits in a diffraction grating using He-Ne laser. **Note:** The list of the experiment given above should be considered as suggestive of the standard and available equipment. The faculty members are authorised to add or delete from this list whenever considered necessary.
12. Book Recommended
1. B.K. Jones, Electronics for Experimentation and Research. Prentice-Hall, ISBN-13 : 978-0132507547 2. R. A. Dunlup, Experimental Physics: Modern Methods, New Delhi: Oxford University Press, ISBN-13 : 978-0195049497 3. K M Varier , A Joseph , Advanced Experimental Techniques in Modern Physics, Anu Books, ISBN: 978-93-86306-29-6

1. Name of the Department: Physics						
2. Course Name	**Spectroscopic Techniques**	**L**	**T**		**P**	
3. Course Code	17080410	4	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE(√)**		**SEC()**	
5. Prerequisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 52		**Tutorials = 0**			**Practical = 0**	
8. Course Description:						
This course includes basics of spectroscopy, UV/Visible spectroscopy, Mossbauer and X-ray Photoelectron Spectroscopy, nonlinear phenomenon and applications of Laser spectroscopy.						
9. Course Objectives:						
To understand the basics of different type spectroscopy and topics of current research interest such XPS like ESCA, EDAX etc., chemical shift, stoichiometric analyses and electronic structure.						
10. Course Outcomes (Cos):						
1. Demonstrate the comprehensive theoretical and experimental set up of basic spectroscopic techniques that use different spectroscopy 2. Different Spectroscopy in solving complex problems, and conceptualizing their solutions from Mossbauer and X-ray Photoelectron Spectroscopy 3. Experimental set up theoretical based skill in the spectroscopic and laser applications 4. Techniques and instrumentation for laser and spectroscopy with concepts and phenomena that are characteristic of lasers						
11. Unit wise detailed content						

Unit-1	Number of lectures = 13	Title of the unit: Basics of Spectroscopy and UV/Visible spectroscopy
Basics of Spectroscopy, Energy of electromagnetic radiation, Quantization of energy, Mechanisms of interaction of electromagnetic radiation with matter, Absorption peaks and line widths. UV/Visible Absorption Spectroscopy, Beer Lambert law, Deviations from Beer Lambert's law.		
Unit – 2	**Number of lectures = 13**	**Title of the unit: Mossbauer and X-ray Photoelectron Spectroscopy**
Mossbauer Spectroscopy: the Mossbauer effect, experimental methods, hyperfine interactions, molecular and electronic structures, **X-ray Photoelectron spectroscopy:** Experimental technique, XPS spectra and its interpretations, other derivative forms of XPS like ESCA, EDAX etc., chemical shift, stoichiometric analyses, electronic structure.		
Unit – 3	**Number of lectures = 13**	**Title of the unit: Non-Linear Phenomenon and related spectroscopy**
Non-linear phenomena and generation of short pulses, laser system for spectroscopy, instrumentation for detection of optical signals and time-resolved measurements, absorption spectroscopy, fluorescence spectroscopy, Raman spectroscopy, non-linear spectroscopy, ultra-fast laser spectroscopy.		
Unit – 4	**Number of lectures = 13**	**Title of the unit: Applications of Laser Spectroscopy**
Cooling and Trapping of Atoms, Principles of Doppler Cooling, Polarization Gradient Cooling Qualitative Description of Ion Traps, Optical Traps and Magneto-Optical Traps, Bose Condensation, Applications of Laser.		

12. Brief Description of self- learning / E-learning component:

For basic conceptual understanding and detail study, students may get the study material from the following links.

1. https://nptel.ac.in/courses/102103044/pdf/mod2.pdf
2. https://www.photonics.com/.../Lasers_Understanding_the_Basics
3. https://en.wikipedia.org/wiki/List_of_laser_applications
4. www.bgu.ac.il/~glevi/website/Guides/Lasers.pdf
5. ieeexplore.ieee.org/document/8048469/

13. Books Recommended

1. B.B Laud: Laser and nonlinear optics, ISBN No. 8122403247, 9788122403244, Publisher Wiley 1991

2. Harold J. Metcalf Peter van der Straten, Laser Cooling and Trapping, ISBN No. 978-0-387-98728-6 Springer, 1999.

3. Demtroder and Wolfgang: Laser Spectroscopy: Basic Concepts and Instrumentation and Instrumentation, ISBN No. 978-3-662-05155-9, 2003, Springer-Verlag Berlin Heidelberg

4. Svelto, Orazio : Principles of Lasers, Edition:4, ISBN No. 978-1-4757-6266-2, 1998, Publishers Springer US

3. J. M. Hollas. High Resolution Spectroscopy, 2nd Edit. ISBN: 978-0-471-97421-5, 1998, Wiley Publication

6. Anne Thorne, Spectrophysics, ISBN No. 978-94-009-1193-2, Edition. 1, 1988, Springer Netherlands.

<table>
<tr><td colspan="8">1. Name of the Department: Physics</td></tr>
<tr><td>2. Course Name</td><td>Spectroscopic Techniques-Lab</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td>17080411</td><td>0</td><td colspan="2">0</td><td colspan="2">2</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">DSE (√)</td><td colspan="2">SEC ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td></td><td>6. Frequency (use tick marks)</td><td>Even (√)</td><td>Odd ()</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="8">7. Total Number of Lectures, Tutorials, Practical</td></tr>
<tr><td colspan="2">Lectures = 0</td><td colspan="2">Tutorials = 0</td><td colspan="3">Practical = 26</td></tr>
<tr><td colspan="8">8. Course Description:</td></tr>
<tr><td colspan="8">This course includes basics of spectroscopy, UV/Visible spectroscopy, Mossbauer and X-ray Photoelectron Spectroscopy, nonlinear phenomenon and applications of Laser spectroscopy</td></tr>
<tr><td colspan="8">9. Course Objectives:</td></tr>
<tr><td colspan="8">1. Demonstrate the experimental knowledge of basic spectroscopic techniques that use different spectroscopy and lasers
2. Experimental knowledge of spectroscopy in solving complex problems, and conceptualizing their solutions from Mossbauer and X-ray Photoelectron Spectroscopy
3. Laboratory exercises that illustrate the Provide a degree of experimental skill in the spectroscopic and laser applications
4. Research based knowledge on the techniques and instrumentation for laser and spectroscopy with concepts and phenomena that are characteristic of lasers</td></tr>
<tr><td colspan="8">10. Course Outcomes (Cos):</td></tr>
<tr><td colspan="8">After successful completion of the course, students will be able to correlate the theoretical concepts of different type of spectroscopy and identify its practical applications through experiment procedure and results</td></tr>
<tr><td colspan="8">11. List of Experiments</td></tr>
<tr><td colspan="8">1. To determine the variation of refractive index of the material of prism with wavelength and to verify Cauchy’s dispersion formula.
2. To determine the wavelength of laser using Michelson Interferometer.</td></tr>
</table>

3. Measurement of Raman spectrum of CCl4 by Raman Spectroscopy
4. Measurement and analyses of fluorescence spectra of liquids/solids (I_2) by fluoresce spectra photometer
5. Study of Photo luminance spectra of alkali metal by PL Spectroscopy
6. Measurement and analysis of Sodium by Photoelectron spectroscopy (XPS)
7. Measurement and analysis of ceramics and inorganic oxides by UV/Visible Absorption Spectroscopy
8. Measurement and analysis of emission spectrum Organic and Inorganic compound by Photo luminance spectroscopy
9. Determination of optical band gap using UV visible spectroscopy of Inorganic compounds
10. Study of balanced state of different atoms present in a Organic/Inorganic compound by XPS Spectroscopy
11. Study of lifetime of photo luminance emission spectrum using time resolve spectroscopy
12. Measurement of Band positions and determination of vibrational constants of AlO molecule
13. Measurement of Band positions and determination of vibrational constants of N_2 molecule
14. Measurement of Band positions and determination of vibrational constants of CN molecule

Note: The list of the experiment given above should be considered as suggestive of the standard and available equipment. The faculty members are authorised to add or delete from this list whenever considered necessary.

12. Book Recommended:

1. W. Demtroder: Laser Spectroscopy: Basic Concepts and Instrumentation and Instrumentation, ISBN No. 978-3-662-05155-9, 2003, Springer-Verlag Berlin Heidelberg.

2. J. M. Hollas. High Resolution Spectroscopy, 2nd Edit. ISBN: 978-0-471-97421-5, 1998, Wiley Publication

3. Anne Thorne, Spectrophysics, ISBN No. 978-94-009-1193-2, Edition. 1, 1988, Springer Netherlands.

4. J. M. Hollas. Modern Spectroscopy, ISBN No. 978-0471911210, 1986, Wiley–Blackwell.

Skill Enhancement Course

Semester-I

1. Name of the Department: **Physics**						
2. Course Name	**Computational Methods & Programming (Matlab/Python)**	**L**	**T**		**P**	
3. Course Code	17080108	2	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**		**SEC (√)**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 30		**Tutorials** = 0	**Practical** = 0			

8. Course Description:

Many problems in physics need to be solved using computational techniques. This course will teach students how to obtain solutions to system of linear equations, differential equations, etc using computational methods.

9. Course Objectives:

To impart the basic knowledge of computers and MATLAB programming. To give exposure about various computational techniques to solve physics using advance computer programming languages.

10. Course Outcomes (Cos):

1. To have basic understanding of MATLAB /Python and be able to design, code, and test small programs.
2. Be fluent in the use of procedural statements assignments, conditional statements, and loops.
3. Self-directed and Life-long Learning.
4. Provide an introduction to the Python programming language.

11. Unit wise detailed content

Unit-1	**Number of lectures = 9**	**Title of the unit: Programming in MATLAB**

Introduction to MATLAB, arrays, loops, Element by element operations, built in function for analysing arrays, Creating and saving a script files, output commands. Symbolic Math and Applications in Numerical Analysis Solving an equation with one variable, finding a minimum or a maximum of a function, Numerical integration, Ordinary differential equations, Interpolation etc, Symbolic Math: symbolic objects and symbolic expressions, creating symbolic objects, creating symbolic expressions.		
Unit – 2	**Number of lectures = 7**	**Title of the unit: Roots of Equations**
Roots of quadratic equation – Limits for real roots of a polynomial equation – Bisection method, False position method and Newton Raphson method for finding roots of the equations.		
Unit – 3	**Number of lectures = 7**	**Title of the unit: Linear Algebra**
Eigen values and Eigen vector of matrix-inverse of a matrix- determinant – solution of linear systems of equations- Gauss elimination and pivotal condensation methods.		
Unit – 4	**Number of lectures = 7**	**Title of the unit: Integration and differentiation**
Trapezoidal rule-Simpson's rule (one -third) solution of ordinary differential equation by Euler method and Runge-Kutta methods, Monte-Carlo Simulation and its applications		

12. Brief Description of self learning / E-learning component

https://www.edx.org/course/programming-basics

https://www.edx.org/course/computational-methods-forpes-harvardx-423x-2

13. Books Recommended

1. Matlab: A Practical Introduction to Programming and Problem Solving 3rd Edition. By Stormy Attaway (Author). ISBN-10 : 0124058760, ISBN-13 : 978-0124058767
2. https://www.math.unipd.it/~mrrusso/Didattica/NA-Yaounde/Manual.pdf.
3. E. Balagurusamy. Numerical Methods. New Delhi: Tata McGraw-Hill, 1999. ISBN-10 : 0074633112, ISBN-13 : 978-0074633113
4. A.K. Ghattak, T.C. Goyal and S.J. Chua. Mathematical Physics. New Delhi: Macmillan, 1995. ISBN-10 : 9386202018, ISBN-13 : 978-9386202017

Semester-II

<table>
<tr><td colspan="7">1. Name of the Department: Physics</td></tr>
<tr><td>2. Course Name</td><td>Physics of Nanomaterials</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td>17080208</td><td>2</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">DSE ()</td><td colspan="2">SEC (√)</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td></td><td>6. Frequency (use tick marks)</td><td>Even (√)</td><td>Odd ()</td><td>Either Sem()</td><td>EverySem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical</td></tr>
<tr><td colspan="2">Lectures = 30</td><td colspan="2">Tutorials = 0</td><td colspan="3">Practical = 0</td></tr>
<tr><td colspan="7">8. Course Description:</td></tr>
<tr><td colspan="7">It includes Fundamental of Nanomaterials, Nanofabrication Techniques, Characterization of Nanomaterials and Nanomaterials and Devices</td></tr>
<tr><td colspan="7">9. Course Objectives:</td></tr>
<tr><td colspan="7">The course aims to provide students with an understanding of the basics of nanomaterials, techniques used in fabrication of nanomaterials, characterization of different types of nanomaterials. It also gives the idea how to design electric devices, magnetic and gas sensors etc. using nanomaterials.</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs):</td></tr>
<tr><td colspan="7">After the successful completion of the course, students would be able to
1. understand the fundamentals of nanomaterials.
2. understand different fabrication techniques for the nanomaterials
3. understand the basics of the different characterization techniques used in basic research in the field of nanoscience.
3. describe the basic involved in the design of devices based on nanotechnology.</td></tr>
<tr><td colspan="7">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td>Number of lectures = 12</td><td colspan="5">Title of the unit: Fundamental of Nanomaterials</td></tr>
<tr><td colspan="7">Definition of nanotechnology, Nanomaterials, Novel combination of properties of materials of nanoscale, Functional enhancement, Size dependence on melting point, Size dependence on vapour pressure, Nucleation, Size dependence on Chemical reactivity, Intermolecular interactions, Size dependence on Surface tension of</td></tr>
</table>

solid surfaces, Quantum confinement & energy levels, Band structure, Density of states in 0D, 1D, 2D & 3D materials, Quantum dots, wires, & wells.		
Unit - 2	**Number of lectures = 14**	**Title of the unit:** Nanofabrication Techniques
Top down and bottom up approaches to nanofabrication, Nucleation & growth mechanism, Optical & electron beam lithography, Thin films deposition, Evaporation, Sputtering, Electrode position and sol Gel Technique, Plasma assisted chemical vapour deposition, Molecular beam epitaxy, Atomic layer deposition.		
Unit - 3	**Number of lectures = 12**	**Title of the unit:** Characterization of Nanomaterials
X-ray diffraction techniques, Scanning transmission electron microscopy, SEM, TEM, Contact &Non-contact methods of surface characterization, Atomic force microscopy, Surface plasma resonance techniques, Electron spectroscopy techniques like AES, XPS, SIMS		
Unit - 4	**Number of lectures = 14**	**Title of the unit:** Nanomaterials and Devices
Carbon based nanomaterials, Small and Large Fullerenes and Other Buckyballs, Carbon nanotubes and their Electronic structure, Graphene, Metal matrix composites, Single electron devices, Molecular electronic devices, Coupled quantum dots, Spintronics, Ultra-sensitive magnetic sensors, Spin dependent transistors, Photonic devices,		

12. Brief Description of self-learning / E-learning component:

To understand basic concepts in detail, students may get study materials on following links.

https://onlinecourses.nptel.ac.in/noc18_ph02
https://ocw.mit.edu/courses/physics/
https://www.mooc-list.com/

13. Books Recommended

1. John H. Davies. The Physics of Low Dimensional Semiconductors. Cambridge University Press.
2. J.J. Ramsden. Nanotechnology- An Introduction. William Andrew Elsevier.
3. Ning Xi and King W. Chiu Lai. Nano-optoelectronics Sensors and Devices. William Andrew Elsevier.
4. V.V. Mitin, V.A. Kochetp and M.A. Stroscio. Quantum Heterostructures: Microelectronics and Optoelectronics. Cambridge University Press.
5. G. Cao. Nanostructures and Nanomaterials: Synthesis, Properties and Applications. Imperial College Press.
6. C.P. Poole and F.J. Owens. Introduction to Nanotechnology. New York: John Wiley. M. Wilson, K. Kannangara, M. Simmons and B. Raguse. Nanotechnology. Overseas Press.

Semester-III

1. Name of the Department: Physics						
2. Course Name	**Lasers and its applications**	**L**	**T**		**P**	
3. Course Code	17080301	2	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**		**SEC (√)**	
5. Pre-requisite (if any)	Physics at graduation level	**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 30		**Tutorials = 0**	**Practical = 0**			
8. Course Description:						
This course provides an introduction to the fundamental principles governing the operation and design of coherent light sources and applications of lasers.						
9. Course Objectives:						
The aim of this course is to 1. understand the fundamentals of LASERs. 2. understand the unique properties of LASERs. 3. explain the different types of LASERs. 4. demonstrate the applications of LASER.						
10. Course Outcomes (COs):						
After the successful completion of the course, students would be able to 1. describe spontaneous and stimulated emission, population inversion and other basic concepts of LASER. 2. describe properties of LASER and various methods of pulsing techniques. 3. understand the construction and working of different types of LASER. 4. understand the applications of different LASERs						
10. Unit wise detailed content						

Unit-1	Number of lectures = 8	Title of the unit: Basic concepts of LASER
Introduction to LASERs, Interaction of Light with matter, Einstein's concept of stimulated emission, Calculation of Einstein's coefficients, Population inversion, 3-level system and 4-level system, components of LASERs,		
Unit – 2	**Number of lectures = 7**	**Title of the unit: Properties of Laser & Pulsing techniques**
Modes of LASER cavity and standing waves, Transverse modes of Laser Cavity. Continuous and pulsed Lasers. Properties of Laser: Directionality, Intensity, Coherence and Monochromaticity. **Pulsing Techniques:** Cavity dumping, Q – switching, Mode locking.		
Unit – 3	**Number of lectures = 8**	**Title of the unit: Types of LASERs**
Types of Lasers: Solid State LASERs (Ruby LASER), Atomic and Ionic Gas LASERs (He-Ne LASER), Molecular Gas LASERs ($CO_2 \quad LASER$), Chemical LASERs (Iodine LASER).		
Unit – 4	**Number of lectures = 7**	**Title of the unit: LASER applications**
Laser applications: Medical, Defense and Transport usages, LIDAR technique, Internet of Thing sensors, rocket navigation, communication, LASER spectroscopy, barcode processing, printing.		

11. Brief Description of self -learning / E-learning component

https://nptel.ac.in/courses/104104085/12
https://ocw.mit.edu/resources/res-6-005-understanding-lasers-and-fiberoptics-spring-2008/laser-fundamentals-i/

12. Books Recommended

1. A.K. Katiyar, C.K. Pandey, Manisha Bajpai, Fundamentals of Laser Systems and Applications, Wiley, ISBN : 978-8126568260
2. Dr M N Avadhanulu, Dr P S Hemne, An Introduction to Lasers: Theory and Applications, S Chand, ISBN: 9788121920711
3. K Thyagrajan, AGhatak, Lasers: Fundamentals and Applications, Springer, ISBN : 978-9352745531

Ability Enhancement Compulsory Course (AECC)

Semester-I

<table>
<tr><td colspan="7">1. Name of the Department: Physics</td></tr>
<tr><td>2. Course Name</td><td>Professional ethics and human value</td><td colspan="2">L</td><td>T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td>17080107</td><td colspan="2">2</td><td>0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td>DSE ()</td><td>AECC (✓)</td><td>SEC ()</td><td>OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>NA</td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical</td></tr>
<tr><td colspan="2">Lectures = 30</td><td colspan="2">Tutorials = 0</td><td colspan="3">Practical = 0</td></tr>
<tr><td colspan="7">8. Course Description:</td></tr>
<tr><td colspan="7">This course provides students with the knowledge of ethics in professional life. Some of the examples from history and day to day life will make the students more responsible towards their profession, society and family.</td></tr>
<tr><td colspan="7">9. Course Objectives:</td></tr>
<tr><td colspan="7">1. To develop ethical and human values in students
2. To develop the responsibility in students at professional and societal levels.</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs):</td></tr>
<tr><td colspan="7">1. The students will understand the values of professional ethics and moral values deeply.
2. The students will be able to take strong decisions and perform their duties responsibly as on professional.</td></tr>
<tr><td colspan="7">11. Unit wise detailed content</td></tr>
</table>

Unit-1	Number of lectures = 8	Title of the unit: Ethics and Human Values
Definition, History and Development of Ethics, Universal declaration on Bioethics. Theories related to Bioethics: Utilitarian theory, Deontological theory and Communication theory		
Unit-1	**Number of lectures = 7**	**Title of the unit: Human Values**
Human Rights and Values: Autonomy, Consent, Equality, Confidentiality, Vulnerability and Personal Integrity Environmental Ethics, Animal ethics		
Unit – 2	**Number of lectures = 7**	**Title of the unit: Professional Ethics**
Need and Importance of professional ethics, Goals, Dignity of Labour, IRB & its functions, Authorship Religious and Cultural Values, Importance of a Family, Guidance to youngsters, Gender Equality		
Unit – 2	**Number of lectures = 8**	**Title of the unit: Responsibility**
Responsibilities towards Safety and Risk, Voluntary v/sIn voluntary Risk, Designing/Research for Safety – Risk, Benefit Analysis, Accidents. Disaster ethics, Ethics in Media and Technology, Research Ethics, Intellectual Property Rights.		
12. Brief Description of self learning / E-learning component		
https://www.youtube.com/watch?v=cFOZplkRqsk&authuser=2 https://www.youtube.com/watch?v=HJk1Eodmf9A&authuser=2 https://www.youtube.com/watch?v=Fqt7m8LH5GY&authuser=2 https://youtu.be/2VYF_t51FyE https://youtu.be/hjzA_rZG-bU		
13. Books Recommended		
1. Professional Ethics and Morals by Prof.A.R.Aryasri, DharanikotaSuyodhana – Maruthi Publications, ISBN (13) : 978-81-224-2301-3 2. Professional Ethics and Human Values by A. Alavudeen, R.Kalil Rahman and M. Jayakumaran – University Science Press, ISBN 0-07-084175-6 3. Professional Ethics and Human Values by Prof.D.R.Kiran-Tata McGraw-Hill – 2013, ISBN : 978-81-224-2301-3		

Semester-II

<table>
<tr><td colspan="2">1. Course Name</td><td colspan="2">Research Methodology and Technical Writing</td><td colspan="2">L</td><td colspan="2">T</td><td>P</td></tr>
<tr><td colspan="2">2. Course Code</td><td colspan="2">17080207</td><td colspan="2">2</td><td colspan="2">0</td><td>0</td></tr>
<tr><td colspan="3">3. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="3">DSE ()</td><td colspan="2">AECC (✓)</td></tr>
<tr><td colspan="2">4. Pre-requisite (if any)</td><td>B.Sc.</td><td>5. Frequency (use tick marks)</td><td>Even (✓)</td><td colspan="2">Odd ()</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="9">6. Total Number of Lectures, Tutorials, Practical</td></tr>
<tr><td colspan="3">Lectures = 30</td><td colspan="3">Tutorials = Nil</td><td colspan="3">Practical = Nil</td></tr>
<tr><td colspan="9">7. Course Description:</td></tr>
<tr><td colspan="9">This course offers an overview of research methodology including basic concepts employed in quantitative and qualitative research methods. The need for research and literature review, steps in conducting research, research methods associated with conducting scholarly research, lab safety measures, ethical, legal social & scientific issues in research are included.</td></tr>
<tr><td colspan="9">8. Course Objectives:</td></tr>
<tr><td colspan="9">The objectives of this course are to:
1. understand some basic concepts of research and its methodologies
2. identify appropriate research topics
3. select and define appropriate research problem and parameters
4. organize and conduct research in a more appropriate manner
5. write a research report and thesis</td></tr>
<tr><td colspan="9">9. Course Outcomes (COs):</td></tr>
</table>

On completion of the course, each student will be able to:

1. have basic knowledge on qualitative research techniques.
2. have adequate knowledge on measurement & scaling techniques as well as the quantitative data analysis.
3. demonstrate knowledge of research processes (reading, evaluating, and developing).
4. perform literature reviews using print and online databases.
5. identify, explain, compare, and prepare the key elements of a research proposal/report.

10. Unit wise detailed content

Unit-1	**Number of lectures = 8**	**Title of the unit: Introduction of Research Methodology**

Introduction and basic concepts in Research Methodology: Meaning of research, objectives and significance of research, Criteria for good research & problems encountered by research scholars.

Unit-2	**Number of lectures = 8**	**Title of the unit: Identification of Research Problems**

Research Problem: Necessity and techniques of defining research problem, Formulation of research problem, Objectives of research problem

Literature search- source of information

Unit – 2	**Number of lectures = 8**	**Title of the unit: Research Design**

Research Design: Meaning, need and features of good research design, Basic Principles of Experimental Designs, Design of experiments and performing experiment.

Data Collection and Validation: Primary & secondary data collection, case study method etc. Data preparations, processing, analysis & interpretation

Unit – 4	**Number of lectures = 6**	**Title of the unit: Report Writing**

Writing of report: Basic concepts of paper, their writing, review of literature, Concepts of Bibliography and References, significance of report writing, steps of report writing

11. Brief Description of self learning / E-learning component

1. http://www2.ift.ulaval.ca/~chaib/IFT-6001/articles/RMethodology_Marzuki_1.pdf
2. https://shodhganga.inflibnet.ac.in/bitstream/10603/71970/14/14_chapter%204.pdf
3. http://www.tamuc.edu/academics/cvSyllabi/syllabi/201440/40503.pdf

12. Books Recommended

1. Blum, Deborah and Mary Knudson, eds. A field guide for science writers: the official guide of the National Association of Science Writers, New York: Oxford University Press, 1997.
2. Davis, Martha. Scientific Papers and Presentations. San Diego: Academic Press, 1997.
3. Fuscaldo, AA, Erlick, BI, Hindman, B. Laboratory Safety: Theory and Practice. New York: Academic Press, 1980.
4. Bajpai, PK. Biological Instrumentation and Methodology. New Delhi: S. Chand & Co. Ltd. 2006.
5. CR Kothari, Research Methodology: Methods & techniques, Gaurav Garg. New Age Publishers.

Note: Syllabus to be revised and updated every two years based upon the academic, industrial and scientific needs.