Program Outcomes

PO-1: Knowledge and Problem Solving Acquire in-depth scientific knowledge of their discipline both in theory and practical, demonstrate basic skills, investigate,apply, and solve the problems in a variety of contexts related to science and technology.

PO-2: Communication and Teamwork - Develop skills to communicate effectively to diverse platforms and contribute meaningfully to different capacities as a leader, team member or individual.

PO-3: Modern tools and techniques for Scientific Experiments – Apply modern tools and techniques to carry out scientific experiments accurately, record, analyze and predict the result for valid conclusion with clear understanding of limitations.

PO-4: Logical thinking: Develop logical thinking and expertise with precision, analytical mind, innovative thinking, clarity of thought, and systematic approach for proving or disproving the facts after mathematical formulation. with precision, analytical mind, innovative thinking, clarity of thought, expression, and systematic approach

PO-5: Skill development and Employability: develop elementary computing and soft skills toprepare students for industry, entrepreneurship and higher education with precision, analytical mind, innovative thinking, clarity of thought, expression, and systematic approach.

PO-6: Ethics and citizenship: Able to recognize different value systems and ethical principles; and commit to professional ethics, norms, and responsibilities of the science practice and act with informed awareness to participate in civic life activities.

PO-7: Society, Environment and Sustainability: Enhance ability to elicit views of others and understand the impact of various solutions in the context of societal, economic, health, legal, safety and environment for sustainable development.

PO-8: Life-long learning: Acquire fundamental knowledge for lifelong learning to participate in the extensive context of socio-technological change as a self-directed member and a leader.

Programme Specific Outcomes

PSO1: Students will demonstrate proficiency in mathematics and the mathematical concepts needed for a proper understanding of physics.

PSO2: Students will demonstrate knowledge of classical mechanics, electromagnetism and modern physics and be able to apply this knowledge to analyze a variety of physical phenomena.

PSO3: Students will show that they have learned laboratory skills, enabling them to take measurements in a physics laboratory and analyze the measurements to draw valid conclusions.

PSO4: Students will be capable of oral and written scientific communication and will prove that they can think critically and work independently.

PSO5: Students will gain basics of modern physics.

OP JINDAL UNIVERSITY

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Department of Physics, School of Science

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Programme: **B.Sc. (Hons) Physics** **Semester : I Sem**
Name of the Course: **Mechanics** **Course Code: SOS-B-PH101**
Credits : 6 **No of Hours :**
Max Marks: 100

Course Description:

This course reviews the concepts of mechanics learnt at school from a more advanced perspective and goes on to build new concepts. It begins with Newton's Laws of Motion and ends with the Fictitious Forces and Special Theory of Relativity. Students will also appreciate the Collisions in CM Frame, Gravitation, Rotational Motion and Oscillations. The students will be able to apply the concepts learnt to several real world problems.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Understand the motion of objects in different frames of references.
CO2	Understand laws of motion, reference frames, and its applications i.e. projectile motion, simple harmonic oscillator, Rocket motion, elastic and inelastic collisions.
CO3	Understand the idea of conservation of angular momentum, central forces and the effective potential.
CO4	Understand the application of central force to the stability of circular orbits, Kepler's laws of planetary motion, Orbital Precession and Rutherford scattering.
CO5	Understand the basics of material properties like, elasticity, elastic constants and their relation, torsion of a cylinder, bending of a beam, cantilever, beam supported at its ends and loaded in the middle.
CO6	Understand the basics of material properties like, elasticity, elastic constants and their relation, torsion of a cylinder, bending of a beam, cantilever, beam supported at its ends and loaded in the middle

CO7	Understand the concept of inertial reference frames and Galilean transformations.

Syllabus:

Special Theory of Relativity
Michelson-Morley Experiment and its outcome. Postulates of Special Theory of Relativity. Lorentz Transformations. Length contraction. Time dilation. Relativistic transformation of velocity, Relativistic addition of velocities. Variation of mass with velocity. Mass-energy Equivalence. Relativistic Doppler effect.

Oscillations:
SHM: Simple Harmonic Oscillations. Differential equation of SHM and its solution. Kinetic energy, potential energy, total energy and their time-average values. Damped oscillation. Forced oscillations: Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor.

Rotational Dynamics
Centre of Mass and Laboratory frames. Angular momentum of a particle and system of particles, Torque. Principle of conservation of angular momentum. Moment of Inertia, Calculation of moment of inertia for rectangular, cylindrical and spherical bodies

Non-Inertial Systems
Non-inertial frames and fictitious forces. Uniformly rotating frame. Laws of Physics in rotating coordinate systems. Centrifugal force. Coriolis force and its applications.

Gravitation and Central Force Motion
Law of gravitation. Gravitational potential energy, Inertial and gravitational mass. Potential and field due to spherical shell and solid sphere, Motion of a particle under a central force field. Two-body problem and its reduction to one-body problem and its solution. The energy equation and energy diagram. Kepler's Laws. Satellite in circular orbit and applications. Geosynchronous orbits.

Elasticity
Elasticity, Stress and Strain, Hook's law, Types of elasticity, Young Modulus, Bulk Modulus, Modulus of rigidity, Relation between elastic constants, Poission's ratio, Cantilever.

BOOKS FOR REFERENCE:

1. An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.

2. Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill.

3. Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.

4. Analytical Mechanics, G.R. Fowles and G.L. Cassiday. 2005, Cengage Learning.

5. Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education

6. Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.

7. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

8. Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000

9. University Physics. F.W Sears, M.W Zemansky, H.D Young 13/e, 1986, Addison Wesley

10. Physics for scientists and Engineers with Modern Phys., J.W. Jewett, R.A.Serway, 2010, Cengage Learning

11. Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.

12. Mechanics - J. C. Slater and N. H. Frank (McGraw-Hill).

CO-PO & PSO Correlation

Course Name : Mechanics (SOS-B-PH101)													
	Program Outcomes								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:	2			1	1			1	3	1	2	1	2
CO2:		1	2		1	1	2			2	2	2	1
CO3:		1		1	2	2		2		1			
CO4:	2								2		1	2	2
CO5:	1	3	1	2	1	2		1	2	1	3	1	3
CO6:	2		3	1	1		2		3	1	3	1	2
CO7:	1	1		2		1	1	1	1			1	2

Note: 1: Low 2.: Moderate 3: High

MECHANICS Lab (SOS-B-PH101)

Course Description:
This course deals with the practical knowledge of mechanics course, which involves various mechanics-related experimental work by students.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Gain knowledge to practically determine moment of inertia of fly wheel.
CO2	Understand how to practically determine acceleration due to gravity.
CO3	Practical determination of Young Modulus of a wire.
CO4	Elastic Constants of a wire by Searle's method.

Syllabus:

At least 6 experiments from the following:

1. To determine the Moment of Inertia of a Flywheel.
2. To determine **g** and velocity for a freely falling body using Digital Timing Technique
3. To determine the Young's Modulus of a Wire by Optical Lever Method.
4. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
5. To determine the elastic Constants of a wire by Searle's method.
6. To determine the value of g using Bar Pendulum.
7. To determine the value of g using Kater's Pendulum

CO-PO & PSO Correlation

Course Name : Mechanics Lab (SOS-B-PH101)													
	Program Outcomes								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:	2	2	2	2	2	1	2	1	3	1	2	1	2
CO2:	2	1	2	2	1	1	1	2	2	2	2	2	1
CO3:	1	3	2	1	2	2	1	2	2	1	2	2	2
CO4:	2	2	2	2	2	2	2	1	2	2	1	2	2

Note: 1: Low 2.: Moderate 3: High

Programme:	**B.Sc. (Hons) Physics**	**Semester :**	**I Sem**
Name of the Course:	**Mathematical Physics – I**	**Course Code:**	**SOS-B-PH102**
Credits :	**6**	**No of Hours :**	
Max Marks:	**100**		

Course Description:

The purpose of the course is to introduce students to methods of mathematical physics and to develop required mathematical skills to solve problems in quantum mechanics, electrodynamics and other fields of theoretical physics. The emphasis of course is on applications in solving problems of interest to physicists. The students are to be examined entirely on the basis of problems, seen and unseen.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Learn and understand calculus. Starting with review of differentiation, exponential and logarithm functions, trigonometric functions, plotting functions, differentials and basics of integration.
CO2	Understand Gaussian integrals, integration by parts, differential and integral calculus for many variables, Lagrange multipliers and Jacobins, Taylor series and their applications in physics.
CO3	Understand math of complex number and application of Cauchy-Riemann Equations, Residue Theorem and Taylor Series for analytic functions.
CO4	Understand basics of vector calculus.
CO5	Understand divergence, gradient and curl and their physical interpretation.
CO6	Understand divergence theorem, Green's theorem, Stokes' theorem and appreciate its applications.
CO7	Understand basics of matrices and determinants i.e. inverses,

	linear vector spaces, basis, basis transformations and linear operators, determinants, eigenvalues, eigenvectors, simple applications, and basics of tensors.

Syllabus:

Vector Algebra
Properties of vectors. Scalar product and vector product, Scalar triple product and their interpretation in terms of area and volume respectively. Scalar and Vector fields.

Vector Differentiation
Directional derivatives and normal derivative. Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field. Del and Laplacian operators. Vector identities.

Vector Integration
Ordinary Integrals of Vectors. Multiple integrals, Jacobian. Notion of infinitesimal line, surface and volume elements. Line, surface and volume integrals of Vector fields. Flux of a vector field. Gauss' divergence theorem, Green's and Stokes Theorems and their verification.

Calculus
Plotting of functions. Approximation: Taylor and binomial series (statements only). First Order Differential. Equations exact and inexact differential equations and Integrating Factor. Second Order Differential equations: Homogeneous Equations with constant coefficients. Particular Integral with operator method, method of undetermined coefficients and variation method of parameters.

Orthogonal Curvilinear Coordinates
Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems.

BOOKS FOR REFERENCE:

1. G.B. Arfken, H.J. Weber, F.E.Harris , Mathematical Methods for Physicists, ,7th E dn., Elsevier, 2013.

2. E.A. Coddington, An introduction to ordinary differential equations, PHI learning, 2009.

3. George F. Simmons, Differential Equations, , McGraw Hill ,2007.

4. D.G. Zill and W.S. Wright, Advanced Engineering Mathematics, 5 Ed., Jones and Bartlett Learning, 2012.

5. Goswami, Mathematical Physics, 1st edition, Cengage Learning

6. S.Pal and S.C. Bhunia, Engineering Mathematics, Oxford University Press , 2015.

CO-PO & PSO Correlation

Course Name : Mathematical Physics – I (SOS-B-PH102)													
	Program Outcomes								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:	1	3	1	2	1	2		1	2	1	3	1	3
CO2:	1	1		2		1	1	1	1			1	
CO3:	2		3	1	1		2		3	1	3	1	2
CO4:	1	3	1	2	1	2	1	3	1		2	1	
CO5:		1	3	1	2	1	1	2		3	2	1	1
CO6:	1	2		1	1	2	3	1	1		2		
CO7:	2	1		1	2	1		2	1	3	1	3	2

Note: 1: Low 2.: Moderate 3: High

MATHEMATICAL PHYSICS-I Lab (SOS-B-PH102)

Course Description:

The course comprises basics of scientific computing: Binary and decimal arithmetic, Floating point numbers, single and double precision arithmetic, underflow and overflow - emphasize the importance of making equations in terms of dimensionless variables, Iterative methods.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Understand basics of C++.
CO2	Understand Random Number generator.
CO3	Gain computational knowledge of Maclaurin and Taylor's series.
CO4	Computational skills of Arrays and Functions.

Syllabus:

1. C++ Control Statements: if-statement, if-else statement, Nested if Structure, Else-if statement, Ternary operator, Go to statement, switch statement, Unconditional and Conditional looping, While loop, Do-while loop, For loop, nested loops, break and continue statements

Programs:

a. To find roots of a quadratic equation

b. To find largest of three numbers

c. To check whether a number is prime or not

d. To list Prime numbers up to 1000

2. Random Number generator: Generating pseudo random numbers to find value of π using Monte Carlo simulations. To integrate using Monte Carlo Method.

3. Maclaurin and Taylor's series: Approximate functions like sin(x), cos(x) by a finite number of terms of Taylor's series.

4. Arrays and Functions: Sum and average of a list of numbers, largest of a given list of numbers and its location in the list, sorting of numbers in ascending descending order using Bubble sort and Sequential sort, Binary search, 2-dimensional arrays, matrix operations (sum, product, transpose etc).

Numerical differentiation) and Integration (Trapezoidal and Simpson rules), Monte Carlo method: Given Position with equidistant time data calculate velocity and acceleration and vice versa. Find the area of BH Hysteresis loop.

CO-PO & PSO Correlation

Course Name : MATHEMATICAL PHYSICS-I Lab (SOS-B-PH102)													
	Program Outcomes								**PSOs**				
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1:	**3**	**2**	**2**	**2**	**2**	**1**	**2**	**1**	**3**	**2**	**2**	**2**	**2**
CO2:	**2**	**1**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**1**
CO3:	**3**	**3**	**2**	**1**	**2**	**2**	**1**	**1**	**2**	**2**	**2**	**2**	**1**
CO4:	**2**	**2**	**3**	**2**	**2**	**1**	**2**	**1**	**2**	**2**	**1**	**2**	**2**

Note: 1: Low 2.: Moderate 3: High

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Programme:	**B.Sc. (Hons) Physics**	**Semester :**	**II Sem**
Name of the Course:	**Electricity and Magnetism**	**Course Code:**	**SOS-B-PH201**
Credits :	**6**	**No of Hours :**	
Max Marks:	**100**		

Course Description:

This course reviews the concepts of electromagnetism learnt at school from a more advanced perspective and goes on to build new concepts. The course covers static and dynamic electric and magnetic fields, and the principles of electromagnetic induction. It also includes analysis of electrical circuits and introduction of network theorems. The students will be able to apply the concepts learnt to several real world problems.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Understand the basic concepts of electric and magnetic fields.
CO2	Understand the concept of conductors, dielectrics, inductance and capacitance.
CO3	Gain knowledge on the nature of magnetic materials.
CO4	Understand the concept of static and time varying fields.
CO5	Gain knowledge on electromagnetic induction and its applications.
CO6	Gain knowledge on EM waves, propagation and their properties.
CO7	Ability to use Maxwell's equations in calculations featuring: both free and stationary electromagnetic waves.

Syllabus:

Electric Field and Electric Potential: Electric field: Electric field lines. Electric flux. Gauss Law with applications to charge distributions with spherical, cylindrical and planar symmetry.

Electrostatic energy of system of charge: Electrostatic energy of a charged sphere. Conductors in an electrostatic Field. Surface charge and force on a conductor.

Capacitance of a system of charged conductors. Parallel-plate capacitor. Capacitance of an isolated conductor. Method of Images and its application to: (1) Plane Infinite Sheet and (2) Sphere.

Dielectric Properties of Matter: Electric Field in matter. Polarization, Polarization Charges. Electrical Susceptibility and Dielectric Constant. Capacitor (parallel plate, spherical, cylindrical) filled with dielectric. Displacement vector **D**. Relations between **E**, **P** and **D**. Gauss' Law in dielectrics.

Magnetic Field: Magnetic force between current elements and definition of Magnetic Field **B**. Biot-Savart's Law and its simple applications: straight wire and circular loop. Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole). Ampere's Circuital Law and its application to (1) Solenoid and (2) Toroid. Properties of **B**: curl and divergence.

Electromagnetic Induction: Faraday's Law. Lenz's Law. Self Inductance and Mutual Inductance. Reciprocity Theorem. Energy stored in a Magnetic Field
Electrical Circuits: AC Circuits: Kirchhoff's laws for AC circuits. Complex Reactance and Impedance. Series LCR Circuit: (1) Resonance, (2) Power Dissipation and (3) Quality Factor, and (4) Band Width. Parallel LCR Circuit.

BOOKS FOR REFERENCE:

1. Electromagnetism by Pramanik
2. Introduction to Electrodynamics by Griffiths
3. Haliday and Resnik, 'Physics'-Vol. II
4. Fundamentals of Electricity and Magnetism, Arthur F. Kip, 2nd Edn.1981, McGraw-Hill.
5. Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education
6. Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn., 1998, Benjamin Cummings.
7. Electricity and Magnetism, J.H.Fewkes& J.Yarwood. Vol.I, 1991, Oxford Univ. Press.
8. Network, Lines and Fields, John D. Ryder, 2nd Edn., 2015, Pearson.
9. Electricity & Magnetism by J.D.Dubey and R.K.Tiwari
10. Electricity and Magnetism by R. Murugeshan
11. Electricity and Magnetism by Purcell

CO-PO & PSO Correlation

Course Name : Electricity and Magnetism (SOS-B-PH201)													
	Program Outcomes								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5

CO1:	**2**		**1**	**2**		**1**	**1**			**2**	**1**	**1**	**2**
CO2:	**1**	**3**	**1**		**2**	**1**	**1**	**2**	**1**	**3**	**1**	**3**	**2**
CO3:		**1**	**2**	**1**	**1**	**2**		**1**	**2**	**1**		**1**	**1**
CO4:	**1**		**1**	**1**	**1**		**2**	**1**	**1**		**1**	**2**	**1**
CO5:	**1**	**1**	**2**	**3**		**1**		**1**		**2**	**2**		**1**
CO6:	**2**		**2**	**1**	**1**		**1**		**3**	**1**	**1**	**2**	**2**
CO7:	**1**	**2**	**1**		**3**	**1**	**1**	**2**	**1**	**1**		**1**	**2**

Note: 1: Low 2.: Moderate 3: High

ELECTRICITY AND MAGNETISM Lab (SOS-B-PH201)

Course Description:

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Gain practical skills related to electricity and magnetism.
CO2	Understand how to measure unknown Low Resistance using Carey Foster's Bridge.
CO3	Practical knowledge of LRC circuit.
CO4	Practical knowledge to determine self inductance and mutual inductance.

Syllabus:

At least 6 experiments from the following:

1. To study the characteristics of a series RC Circuit.
2. To determine an unknown Low Resistance using Potentiometer.
3. To determine an unknown Low Resistance using Carey Foster's Bridge.
4. Measurement of field strength B and its variation in a solenoid (determine dB/dx)
5. To determine self inductance of a coil by Anderson's bridge.
6. To study response curve of a Series LCR circuit and determine its (a) Resonant frequency, (b) Impedance at resonance, (c) Quality factor Q, and (d) Band width.

7. To study the response curve of a parallel LCR circuit and determine its (a) Anti-resonant frequency and (b) Quality factor Q.

8. Determine a high resistance by leakage method using Ballistic Galvanometer.

9. To determine self-inductance of a coil by Rayleigh's method.

10. To determine the mutual inductance of two coils by Absolute method.

CO-PO & PSO Correlation

Course Name : Electricity and Magnetism Lab (SOS-B-PH201)													
	Program Outcomes								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:	2	2	2	1	2	1	1	1	2	1	1	1	2
CO2:	3	2	1	2	1	1	1	2	3	1	2	1	1
CO3:	2	2	2	1	2	1	2	1	2	1	3	2	1
CO4:	1	3	2	2	2	1	2	1	2	3	1	2	2

Note: 1: Low 2.: Moderate 3: High

Programme: **B.Sc. (Hons) Physics**
Name of the Course: **Analog Systems and Applications**
Credits : **6**
Max Marks: **100**

Semester : **II Sem**
Course Code: **SOS-B-PH202**
No of Hours :

Course Description:
This course introduces the concept of semiconductor devices and their applications. It also emphasizes on understanding of amplifiers, oscillators and d their applications.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Student identifies the relationship and correct usage of work, energy, heat capacity, specific heat, latent heat, and enthalpy.
CO2	Understand Semiconductor diodes, bipolar junction transistor.

CO3	Sketch, explain and design the amplifier circuit for given specification and analyze them discuss oscillator principles, and frequency stability.
CO4	Analyze the dixerent types of Oscillators.
CO5	Understand characteristics and working of pn junction, two terminal devices.
CO6	Understand Designing of different types of oscillators and in the laboratory course.

Syllabus:

Semiconductor Diodes: Doped semiconductors: p and n. Energy Level Diagram and Position of Fermi level. Conductivity, Mobility and Concept of Drift velocity. p-n Junction Formation and barrier potential, Working Mechanism of Forward and Reverse Biased Diodes with Energy Level Diagrams.

Two-terminal Devices and their Applications: Diode rectifier: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers, Calculation of Ripple Factor, and Rectification Efficiency, C-filter, Zener Diode, Zener Diode as a Voltage Regulator, Principle, LED, Photodiode and Solar Cell, Basic idea of Schottky diode and Tunnel diode.

Bipolar Junction transistors and amplifiers: n-p-n and p-n-p Transistors. Working principles of transistors in CB and CE and CC Configurations, I-V characteristics of CB, CE and CC Configurations. Active, Cutoff and Saturation Regions. Current gains α and β. Relations between α and β. Load Line analysis of Transistors. DC Load line and Q point.

Feedback in Amplifiers: Positive and Negative Feedback. Effect of negative feedback on Input Impedance, Output Impedance, Gain, Stability, Distortion and Noise.

Sinusoidal Oscillators: Barkhausen's Criterion for self-sustained oscillations. RC Phase shift oscillator, determination of Frequency. Hartley & Colpitts oscillators.

BOOKS FOR REFERENCE:

1. Semiconductor Devices: Physics and Technology, S.M. Sze, 2nd Ed., 2002, Wiley India
2. Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
3. Microelectronic Devices & Circuits, David A.Bell, 5th Edn.,2015, Oxford University Press
4. Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
5. Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
6. Basic Electronics: A text lab manual, P.B.Zbar, A.P.Malvino, M.A.Miller, 1994, Mc-Graw Hill.

7. Electronics Lab Manual (Volume 2), K. A. Navas, PHI Learning Pvt Ltd; Sixth edition (2018).

CO-PO & PSO Correlation

Course Name : Analog Systems and Applications (SOS-B-PH202)													
	Program Outcomes								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:	1	2	1		1	2		1	1		2	1	1
CO2:		1		3			1			1		2	
CO3:	1		1	1	2		2	1	2		1	1	3
CO4:	2	1		1		1				1			
CO5:		2	2	2		1	1		2		1	1	2
CO6:	1	2	2		1	1	2	1		1	2	1	1

Note: 1: Low 2.: Moderate 3: High

ANALOG SYSTEMS Lab (SOS-B-PH202)

Course Description:

The course involves the practical aspects of analog electronics. Various experiments related to electronics are performed by students to gain practical knowledge of the course: Analog Systems and Applications.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Gain the practical knowledge to determine the V-I characteristics of a pn diode in forward and reverse bias.
CO2	Understand how to practically determine the V-I characteristics of a Zener diode and its use as voltage regulator.
CO3	Practical determination of the characteristics of a Bipolar Junction Transistor in CE configuration.
CO4	Study of V-I & power curves of solar cells, and find maximum power point & efficiency.

Syllabus:

At least 6 experiments from the following:

1. To study the V-I characteristics of a pn diode in forward and reverse bias.
2. To study the V-I characteristics of a Zener diode and its use as voltage regulator.
3. Study of V-I & power curves of solar cells, and find maximum power point & efficiency.
4. To study the characteristics of a Bipolar Junction Transistor in CE configuration.
5. To design a CE transistor amplifier of a given gain (mid-gain) using voltage divider bias.
6. To study the various biasing configurations of BJT.
7. To study the frequency response of Voltage gain of a two stage RC-coupled transistor amplifier.

CO-PO & PSO Correlation

Course Name : ANALOG SYSTEMS Lab (SOS-B-PH202)													
	Program Outcomes								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:	3	2	3	1	3	1	2	1	2	2	1	2	2
CO2:	3	2	1	2	1	1	1	1	3	1	2	1	1
CO3:	2	3	2	1	2	1	3	1	2	1	3	2	1
CO4:	2	3	2	2	2	1	2	2	3	3	1	2	2

Note: 1: Low 2.: Moderate 3: High

Programme: **B.Sc. (Hons) Physics**
Name of the Course: **English Language (2)**
Credits : **2**
Max Marks: **100**

Semester : **I Sem**
Course Code: **SOS-B-AE301**
No of Hours :

Course Description:

Information is crucial to an organisation and when this information is communicated in writing, the quality of such communications can have a significant impact on business performance and decision making. Effective business writing is concise, accurate, unambiguous, logical and easily understood.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Acquaint with different media of communication and its importance.
CO2	Communicate effectively by analyzing audience, organizing documents, writing clearly and precisely with no grammar errors and presenting the document with skillful design.
CO3	Demonstrate the use of basic and advanced proper writing techniques.
CO4	Write informal and formal reports in a structured way.
CO5	Identify barriers to effective communication and how to overcome them.

Syllabus:

An introduction to writing: Definition, Characteristics of effective writing, Principles of writings(7C's), Modes of Writing: Narrative, Descriptive, Argumentative, Expository.

Activity: 1. List out pompous words and change them into simple words

2. List out the ambiguous words and suggest how to avoid it at different situation.

3. Convert the given sentences into concrete expression by avoiding Verbosity.

4. Write a review on a Movie

Sentence structure, Subject-Verb concord, Tenses, Voice, Narration, Identifying common errors in writings, Précis writings, Paragraph writings.

Types of letters, Elements of letters, Styles of letter writing, Basics of official correspondence, Preparation of Resume and Job application, E-mail.

Characteristics of good report, Elements of report, Preparation and writings of report, Use of illustrations in reports, Preparation of Bibliography and References.

Notice, Agenda and Minutes Writing techniques, Tenders, Advertising, Sales Letter.

Reference Books:

1. Introduction to Communication studies- John Fisk, Rotledge London

2. Writing Technical Papers- D.H.Menzel, H.M.Jonest. Mc GrawHill . New Delhi.
3. A Remedial English Grammar for Foreign Students- F.T.Wood Mc Millan India Ltd.
4. Living English Structure- W. Stannard Allen, Orient Longman London Fourth edition.
5. Technical Communication for Engineers by Shalini Verma, Vikas Publishing House.

CO-PO & PSO Correlation

Course Name : English Language (2) (SOS-B-AE301)													
	Program Outcomes								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:	1	2	2	2	1	1	2	2	2	1	2	2	2
CO2:		1	1		1		2		1		1	2	2
CO3:	2		2	1	2	2		2	2	3	2	1	2
CO4:	1	1	2	1	1		2	2	2	1		1	2
CO5:	1	2	2	2	1		2	2	2	1	2	3	1

Note: 1: Low 2.: Moderate 3: High

Programme: **B.Sc. (Hons) Physics** **Semester :** **II Sem**
Name of the Course: **Environmental Science** **Course Code:** **SOS-B-AE301**
Credits : **2** **No of Hours :**
Max Marks: **100**

Course Description:

The following are the objectives of environmental education: Awareness: To help the social groups and individuals to acquire knowledge of pollution and environmental degradation. Knowledge: To help social groups and individuals to acquire knowledge of the environment beyond the immediate environment including distant environment. Attitudes: To help social groups and individuals to acquire a set of values for environmental protection. Skills and Capacity Building: To help social groups and individuals to develop skills required for making discriminations in form, shape, sound, touch, habits and habitats. Further, to develop ability to draw unbiased inferences and conclusions. Participation: To provide social groups and individuals with an opportunity to be actively involved at all levels in environmental decision making.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Gain in-depth knowledge on natural processes and resources that sustain life.
CO2	Understand the consequences of human actions on the web of life and quality of life.
CO3	Develop critical thinking for shaping strategies or environmental protection, conservation of biodiversity, environmental equity, and sustainable development.
CO4	Acquire values and attitudes towards understanding complex environmental-economic-social challenges.
CO5	Gain an understanding of identifying problems, solving current environmental problems and preventing the future ones.

Syllabus:

Ecology and Bio-Diversity

Ecology, Environment & Ecosystem, Biotic & Abiotic Components; Structure & functions of Ecosystem, Productivity, Decomposition, Energy Flow, Nutrient cycling, Food Chain & Food Web, Ecological Pyramids; Ecological succession; Bio-diversity: Concept, Importance, and Threats & Conservation

Environment and Natural Resources

Earth's Environment: Atmosphere, Lithosphere, Hydrosphere & Biosphere, functions and related problems; Environmental degradation and its causes; Natural resources, Renewable and Non-renewable Resources & associated problems; Study of major Resources on Earth (overview): Forest, Water, Mineral, Food, Energy and Land.

Air Pollution

Classification of air pollutants, sources and effects of CO, SOx, NOx, Hydrocarbons, PM, Acid Rain, Ozone, Photochemical Smog & Peroxy Actyl

Nitrate (PAN). Earth's energy balance, Green House Effect, Global warming; Stratospheric Ozone & its Depletion; Ambient Air Quality standard; Air pollution control methods

Water Pollution & Soil Pollution

Point & non-point source; Water pollutants & types, sources and effects; Water Quality measurement, Dissolved Oxygen, BOD & COD; Wastewater Management, Primary, Secondary & Tertiary stages: Objective, Process overview and Equipment used.
Sources of Soil pollution & effect; Solid Waste Management: Objective, Process & Disposal Techniques.

Social issues & Sustainability

Population Growth, variation among nations, Population explosion, Family Welfare Programme; HIV/AIDS; Environment and human health. Concept of Sustainable Development (SD), models, indicators and principles of Sustainability.

References books:

1. Keerthinarayana & Daniel Yesudian, "Environmental Science and Engineering", 1st Edition, Hi-Tech publications, 2004.
2. Erach Bharucha, "A Text Book for Environmental Studies", Text Book of University Grants Commission, 2004.
3. Peavy, H.S., D.R. Rowe & T. George, "Environmental Engineering", New York: Mc Graw Hill, 1987.
4. Metcalf & Eddy, "Wastewater Engineering: Treatment and Reuse", New Delhi, Tata McGraw Hill, 2003.
5. Principles of Environmental Science Inquiry & Applications by W.P. Cunningham & Mary Ann Cunningham (Tata Mc Graw Hill Publishing Company Ltd.).

CO-PO & PSO Correlation

Course Name : Environmental Science (2) (SOS-B-AE301)													
	Program Outcomes								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:	2			1	1			1	3	1	2	1	2
CO2:		1	2		1	1	2			2	2	2	1
CO3:		1		1	2	2		2		1			

CO4:	**2**								**2**		**1**	**2**	**2**
CO5:	**1**	**1**	**2**			**2**	**2**	**2**	**1**	**1**	**1**	**2**	

Note: 1: Low 2.: Moderate 3: High

Programme: **B.Sc. (Hons) Physics** **Semester : I Sem**
Name of the Course: **Professional Development** **Course Code: SOS-B-SE101**
Credits : 2 **No of Hours :**
Max Marks: 100

Course Description:

Professional Development course is designed to teach students to apply theories and principles of effective interpersonal and public speaking. This course provides instruction and experience in preparation and delivery of speeches within a public setting and group discussion. Emphasis is on research, preparation, delivery, and evaluation of informative, persuasive, and special occasion public speaking. Upon completion, students should be able to prepare and deliver well-organized speeches and participate in group discussion with appropriate audiovisual support. Students should also demonstrate the speaking, listening, and interpersonal skills necessary to be effective communicators in academic settings, in the workplace, and in the community.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Recognise the effects of diversity, access and power of communication.
CO2	Write effectively for a variety of contexts and audiences.
CO3	Able to deliver formal and informal presentation to a variety of audiences in multiple context.
CO4	Analyze a problem and devise a solution in a group.
CO5	Understand the scientific methods and capacity to evaluate social

	research.

Note: 1: Low 2.: Moderate 3: High

Syllabus:

Communication, Elements and Process of Communication, principles of communication-7C's of communication, Types of Communication, Medium of communication, Barriers to communication, Effective Listening Skills, Nonverbal Communication.

Speaking: An Overview, Listening Effectively, Non-Verbal Communication, Art of Persuasion, Combating Stage Fright, Describing Objects/Situations/People, Delivering Just-a-minute Sessions, Delivering Different Types of Speeches.

Audio-visual Aids , Planning of a Presentation, Designing of a Presentation, Preparing Power Point Slides for Presentations, Individual and Group Presentations, Making Presentation.

Introduction, GD and Debate, Types of GD, Personality Traits to be evaluated, Dynamics of Group Behaviour, DOs and DON'Ts of GD.

Introduction, Process, Stages in Job Interviews, Types, Desirable Qualities, Preparation, Tips for Success

TEXT BOOKS

1. Improve Your Writing ed. V.N. Arora and Laxmi Chandra, Oxford Univ. Press, New Delhi
2. Technical Communication – Principles and Practices by Meenakshi Raman & Sangeeta Sharma, Oxford Univ. Press 2007, New Delhi.

REFERENCE BOOKS

1. Effective Technical Communication by Barun K. Mitra, Oxford Univ. Press, 2006, New Delhi
2. Business Correspondence and Report Writing by Prof. R.C. Sharma & Krishna Mohan, Tata McGraw Hill & Co. Ltd., New Delhi.
3. How to Build Better Vocabulary by M.Rosen Blum, Bloomsbury Pub. London.
4. Word Power Made Easy by Norman Lewis, W.R.Goyal Pub. & Distributors; Delhi.
5. Developing Communication Skills by Krishna Mohan, Meera Banerji- Macmillan India

Ltd. Delhi.

CO-PO & PSO Correlation

Course Name : Professional Development (SOS-B-SE101)													
	Program Outcomes								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:	2	1	2	2	2	3	1	2	2	1	2	1	2
CO2:	1		2		2	1		1	1	1	1		2
CO3:	2	1	2		1	1		2	3	1	2	1	2
CO4:	2	1	2	1	2	3	1	2	1	2	2	1	2
CO5:	1		1	2			2	1	1	2	1		1

Programme: **B.Sc. (Hons) Physics** **Semester :** **II Sem**

Name of the Course: **Disaster Management** **Course Code:** **SOS-B-SE201**

Credits : **2** **No of Hours :**

Max Marks: **100**

Course Description:

Disasters can be generally categorised as natural and man-made. The man-made disasters have been categorised as nuclear disasters, industrial accidents, environmental disasters, fires, rail accidents, road accidents, air accidents and sea accidents; and natural disasters have been categorised as hydrological, wind-related, geophysical, and climatic. This Course focuses on both natural and man-made disasters. Under each category, an attempt is made to discuss the causes and impacts, along with past illustrations and geographical distribution. Preparedness, response and traditional coping mechanisms pertaining to these disasters are also dealt. This Course further deals with the meaning, observation, perception, and identification of risk and vulnerability factors associated with disasters and includes the lessons learnt and do's and don'ts relating to these disasters. Various aspects of response, such as, minimum standards of relief, management of relief commodities and services, stakeholders' coordination in response, and recovery are covered in this Course. The Course also deals with the various facets of human behaviour and response in disaster situations.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Understand various types of disasters, their preparedness and mitigation measures.
CO2	Understand application of disaster concepts to management.
CO3	Make monitoring and evaluation plan for disaster response.
CO4	Respond early warning systems for risk reductions.
CO5	Understand role of various stack holders during disasters.

Note: 1: Low 2.: Moderate 3: High

Syllabus:

Introduction to disasters, Natural Disasters, Man Made Disasters, Slow Disasters and Rapid Onset Disasters, Political, Social, Economic and Psychological impacts of Disasters, Gender and Social issues during disasters, and recovery during emergency situations.

Introduction to disaster Preparedness- Disaster Management (Prevention, Preparedness and Mitigation), Community based Disaster Preparedness Plan, Roles & Responsibilities of Different Agencies and Govt, Disaster Mitigation.

Response Essential Components (Disaster Response Plan, Communication, Participation and Activation of Emergency Preparedness Plans, Search, Rescue, Evacuation and other logistic management), Stakeholders Co-ordination in Disaster Response, Human Behaviour and Response Management, Disaster Risk Management in India.

Different stake holders in Disaster Relief, Refugee operations during disasters, Human Resettlement and Rehabilitation issues during and after disasters, Reconstruction and Rehabilitation as Means of Development, Education and Awareness, Role of Various Agencies in Recovery Measures.

Hazard, Risk and Vulnerability: Concept and Relationship, Understanding Risk: Concepts and Elements, Disaster Risk Reduction, Risk Analysis Techniques, People Participation in Risk Assessment.

TEXT BOOKS

1. Disaster Management, by Dr. S. Arulsamy & J.JEYADEVI, Neelkamal
2. Disaster Management by Jagbir Singh, APH Publishing Corporation (2008)

REFERENCE BOOKS

1. Natural Hazards and Disaster Management: Vulnerability and Mitigation, by R. B. Singh, Rawat
2. Disaster Management by M. M. Sulphey, PHI Learning (2 May 2016
3. Disaster Management by Harsh K. Gupta (Editor), Universities Press (2003),
4. Handbook of Disaster Management by William L. Waugh, Crest Publishing House
5. Handbook Of Disaster Management: Techniques and Guidelines by B. K. Singh, Rajat Publications.

CO-PO & PSO Correlation

Course Name : Disaster Management (SOS-B-SE201)													
	Program Outcomes								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:	2	2	2		1	2	2	2			1	1	3
CO2:	2	3		1		2	2	1	2	2		2	1
CO3:	1		3	1	1	1	1		3		2	2	2
CO4:	3	1	2	1	2		2			3	1	1	
CO5:	2	2	2		1	2	2	2	1	2	1	2	1

Note: 1: Low 2.: Moderate 3: High

Programme: **B.Sc. (Hons) Physics** **Semester :** **III Sem**

Name of the Course: **Thermal Physics** **Course Code:** **SOS-B-PH301**

Credits : **6** **No of Hours :**

Max Marks: **100**

Course Description:

The primary goal of this course is to understand the fundamental laws of thermodynamics and their applications to various systems and processes. In addition, it will also give exposure to students about the kinetic theory of gases, transport phenomena involved in ideal gases, phase transitions and behavior of real gases.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Comprehend the basic concepts of thermodynamics.
CO2	The first and the second law of thermodynamics.
CO3	Understand the concept of entropy and the associated theorems.
CO4	The thermodynamic potentials and their physical interpretations.
CO5	Know about reversible and Irreversible processes.
CO6	Learn about Maxwell's relations and use them for solving many problems in Thermodynamics

Syllabus:

Fundamentals of Thermodynamics: Introduction to zeroth and first laws of thermodynamics, applications of first law: General Relation between CP and CV, Work Done during Isothermal and Adiabatic Processes, Second law of thermodynamics, Reversible and irreversible processes, Carnot's theorem and its explanation using Carnot's cycle, Concept of entropy, Entropy change in reversible and irreversible processes. Entropy and disorder, Entropy as a thermodynamic variable, S-T diagram.

Thermodynamic potentials: Internal energy, Enthalpy, Helmholtz function and Gibb's free energy, Clausius Clapeyron Equation and Ehrenfest equations, First and second order Phase Transitions.

Maxwell relations: Introduction to Applications of Maxwell's Relations, Applications of Maxwell's Relations: Clausius Clapeyron equation, calculation of Cp-Cv, TdS Equations, and Energy equations.

Kinetic Theory of gases: Maxwell-Boltzmann Law of Distribution of Velocities, Mean free path, Mean, RMS and Most Probable Speeds, Ideal and Real gases, Andrew's curves, Equation of state, Virial coefficients, Van der Waals equation and Critical constants.

Thermal Radiation: Blackbody, spectrum of blackbody radiation, Wien's displacement law, Rayleigh-Jean's law, Planck's quantum theory of radiation, Planck's formula and its derivation, application of Planck's formula.

Reference Books:

1. Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill
2. Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger.

1988, Narosa.
3. Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. Chand Publications.
4. Thermal Physics: B.K. Agarwal.
5. Heat and Thermodynamics: Brij Lal and N. Subramanyam.
6. Advanced Practical Physics for students: B. L. Flint and H.T.Worsnop (Little Hampton Book).
7. A Text Book of Practical Physics : InduPrakash& Ramakrishna(KitabMahal).
8. Advanced level Practical Physics: Nelkon and Ogborn (Heinemann Educational Publ.).
9. An Advanced Course in Practical Physics: D. Chattopadhyay& P. C. Rakshit, (New Central Book Agency).
10. Practical Physics: G.L. Squires (Cambridge University Press).

CO-PO & PSO Correlation

Course Name : Thermal Physics (SOS-B-PH301)													
	Program Outcomes								PSOs				
Course Outcome	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:	1	2	1		3	1	1	2	1	1		1	2
CO2:			2	1	1			1	1	3	2	1	1
CO3:		1		3	2	1	1			1		2	
CO4:	2	1		1		1	2	2	2		1	1	3
CO5:	3			1	3	2		1	1	2	2	1	1
CO6:	1	2	2		1	1	2	1		1	2	1	1

Note: 1: Low 2.: Moderate 3: High

THERMAL PHYSICS Lab (SOS-B-PH301)

Course Description:

The course comprises experimental work related to the thermal physics course. It includes determination of thermal conductivity of a good conductor of heat (metal rod), liquid, study the domestic refrigerator, heat transfer through composite walls, etc.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Gain practical skills of determination of thermal conductivity.
CO2	Practical knowledge of domestic refrigerator.
CO3	Understand different types of temperature measurement techniques.
CO4	Practical study of fuel cells.

Syllabus:

At least five experiments should be performed in the lab:

1. Determination of thermal conductivity of a good conductor of heat (metal rod).
2. To measure the thermal conductivity of liquid.
3. To study the domestic refrigerator.
4. Determination of heat transfer through composite walls.
5. Study of fuel cells.
6. To study different types of temperature measurement techniques.
7. Performance on solar water heating system with flat plate collector.
8. To study the variation of Thermo-emf of a Thermocouple with Difference of Temperature of its Two Junctions using a null method. And also calibrate the Thermocouple in a specified temperature range.
9. To calibrate a thermocouple to measure temperature in a specified Range using Op-Amp difference amplifier and to determine Neutral Temperature.

CO-PO & PSO Correlation

Course Name : THERMAL PHYSICS Lab (SOS-B-PH301)													
	Program Outcomes								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:	3	1	2	1	2	1	2	2	2	2	1	2	1
CO2:	2	2	1	2	1	2	1	1	3	1	2	1	2
CO3:	2	3	2	1	2	2	3	2	2	1	3	1	1
CO4:	3	3	2	3	2	1	2	2	3	3	1	2	1

Note: 1: Low 2.: Moderate 3: High

OP JINDAL UNIVERSITY

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Department of Physics, School of Science

OPJU
UNIVERSITY OF STEEL TECHNOLOGY AND MANAGEMENT

Programme:	**B.Sc. (Hons) Physics**	**Semester :**	**III Sem**
Name of the Course:	**Mathematical Physics – II**	**Course Code:**	**SOS-B-PH302**
Credits :	**6**	**No of Hours :**	
Max Marks:	**100**		

Course Description:

To provide students the ability to hone the mathematical skills necessary to approach problems in advanced physics courses. The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Learn the fundamentals and applications of Fourier series; Fourier and Laplace transforms, their inverse transforms
CO2	Learn special type of matrices that are relevant in physics
CO3	Understand Special functions: Gamma function, Beta function, Delta function, Dirac delta function, Bessel functions
CO4	Learn Different ways of solving second order differential equations
CO5	Familiarized with singular points

Syllabus:

Fourier Series: Periodic functions. Orthogonality of sine and cosine functions, Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients. Even and odd functions and their Fourier expansions. Application. Summing of Infinite Series. Term-by-Term differentiation and integration of Fourier Series.

Special Functions: Legendre, Bessel, Hermite and Laguerre Differential Equations. Properties of Legendre Polynomials: Rodrigues Formula, Generating Function, Orthogonality. Simple recurrence relations. Expansion of function in a series of Legendre Polynomials. Bessel Functions of the First Kind: Generating Function, simple recurrence relations. Zeros of Bessel Functions (Jo(x) and J1(x)) and Orthogonality.

Some Special Integrals: Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions.

Partial Differential Equations: Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular geometry. Solution of wave equation for vibrational modes of a stretched string, rectangular and circular membranes.

Reference Books:

1. Arfken, Weber , Mathematical Methods for Physicists:, Harris, Elsevier2005.
2. M.R. Spiegel , , Fourier Analysis, Tata McGraw-Hill , 2004.
3. Susan M. Lea , Mathematics for Physicists, Thomson Brooks/Cole 2004.
4. George F. Simmons ,Differential Equations, Tata McGraw-Hill , 2006.
5. S.Pal and S.C. Bhunia, Engineering Mathematics, Oxford University Press2015.
6. Mathematical methods for Scientists & Engineers, D.A.McQuarrie, 2003, Viva

CO-PO & PSO Correlation

Course Name : Mathematical Physics – II (SOS-B-PH302)													
	Program Outcomes								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:	1	2	2		1	3	2		1	1	1	3	1
CO2:	1		1	1	2		2	1	2		1	1	1
CO3:	2	1		1		1				1		1	2
CO4:		2	2	2		1	1		2		1	1	
CO5:	1	2	2		1	1	2	1		1	2	1	1

Note: 1: Low 2.: Moderate 3: High

MATHEMATICAL PHYSICS-II Lab (SOS-B-PH302)

Course Description:

The course familiarizes students with different numerical computation softwares to perform Curve fitting, Least square fit, Goodness of fit, standard deviation, Solution of Linear system of equations by Gauss elimination method and Gauss Seidal method. Diagonalisation of matrices, Inverse of a matrix, etc.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Gain experience to use numerical computation software.
CO2	Skills of curve fitting, Least square fit, Goodness of fit, standard deviation using computation software.
CO3	Gain knowledge to solve Linear system of equations by Gauss elimination method and Gauss Seidal method.
CO4	Experience in generation of Special functions using User defined functions in computational software.

Syllabus:

1. Introduction to Numerical computation software.

2. Curve fitting, Least square fit, Goodness of fit, standard deviation using computation software.

- ❖ Ohms law calculate R, Hookes law, Calculate spring constant,
- ❖ Given Bessel's function at N points find its value at an intermediate point.

3. Solution of Linear system of equations by Gauss elimination method and Gauss Seidal method. Diagonalisation of matrices, Inverse of a matrix.

4. Generation of Special functions using User defined functions in computational software.

CO-PO & PSO Correlation

Course Name : MATHEMATICAL PHYSICS-II Lab (SOS-B-PH302)													
	Program Outcomes								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:	3	1	2	1	2	1	2	1	2	2	2	2	1
CO2:	2	2	2	2	1	2	1	2	3	1	1	1	2
CO3:	1	3	3	1	3	2	3	2	2	1	3	1	2
CO4:	3	3	2	3	2	1	2	1	3	2	1	2	1

Note: Low 2.: Moderate 3: High

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Department of Physics, School of Science

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UNIVERSITY OF STEEL TECHNOLOGY AND MANAGEMENT

Programme:	**B.Sc. (Hons) Physics**	**Semester :**	**III Sem**
Name of the Course:	**Digital Systems and Applications**	**Course Code:**	**SOS-B-PH303**
Credits :	**6**	**No of Hours :**	
Max Marks:	**100**		

Course Description:

This is one of the core papers in physics curriculum which introduces the concept of Boolean algebra and the basic digital electronics. In this course, students will be able to understand the data processing circuits, Arithmetic Circuits, sequential circuits like registers, counters etc. based on flip flops. In addition, students will get an overview of microprocessor architecture and programming.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Learn basics of active and passive components.
CO2	Learn concept of Integrated Chips (IC): its classification and uses.
CO3	Differentiate the Analog and Digital circuits.
CO4	Understand the concepts of number systems.
CO5	Learn Sequential Circuits: Flips-Flops, shift registers and 4-bits counters.
CO6	Understand the concept of RAM, ROM and memory organization.
CO7	Design Timer circuits using IC 555 and multivibrators using 555 ICs.
CO8	Learn Basic architecture of processing in an Intel 8085 and 8086 microprocessors.

Syllabus:

Integrated Circuits: Active and Passive components, Discrete components. Wafer. Chip. Advantages and drawbacks of ICs. Scale of integration: SSI, MSI, LSI and VLSI (basic idea and definitions only). Classification of ICs. Examples of Linear and Digital ICs.

Digital Circuits: Difference between Analog and Digital Circuits. Binary Numbers. Decimal to Binary and Binary to Decimal Conversion. BCD, Octal and Hexadecimal numbers. AND, OR and NOT Gates (realization using Diodes and Transistor). NAND and NOR Gates as Universal Gates. XOR and XNOR Gates and application as Parity Checkers, De Morgan's Theorems.

Data processing circuit and Arithmetic Circuits: Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders. Half & Full Subtractors, 4-bit binary Adder/Subtractor, SR, D, and JK Flip-Flops. Clocked (Level and Edge Triggered) Flip-Flops. Preset and Clear operations. Race-around conditions in JK Flip-Flop. M/S JK Flip-Flop, IC555: block diagram and applications: Astable multivibrator and Monostable multivibrator.

Registers and counters: Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel-in-Parallel-out Shift Registers, Ring Counter. Asynchronous counters, Decade Counter. Synchronous, Counter.

Microprocessors and Computer Organization: Microprocessors: Intel 8085 and 8086 microprocessor architectures, Computer organization: Computer Organization: Input/Output Devices. Data storage (RAM and ROM), Computer memory. Memory organization and addressing. Memory Interfacing. Memory Map.

Reference Books:

1. Digital Electronics, S.K. Mandal, 2010, 1st edition, McGraw Hill
2. Fundamentals of Digital Circuits, Anand Kumar, 2nd Edn, 2009, PHI Learning Pvt. Ltd.
3. Digital Principles and Applications, A.P.Malvino, D.P. Leach and Saha, 7th Ed.,

2011, Tata McGraw.
4. Microprocessor Architecture Programming & applications with 8085, 2002, R.S. Goankar, Prentice Hall.
5. Microprocessors and Microcontrollers: 8085, 8086 and 8051, A. K. Ganguli, Anuva Ganguly, Alpha Science Intl Ltd; 1 edition (January 31, 2012).
6. Modern Digital Electronics, R.P. Jain, 4th Edition, 2010, Tata McGraw Hill
7. Basic Electronics: A text lab manual, P.B.Zbar, A.P.Malvino, M.A.Miller, 1994, Mc-Graw Hill.
8. Microprocessor 8085: Architecture, Programming and interfacing, A.Wadhwa,2010, PHI Learning.

CO-PO & PSO Correlation

Course Name : Digital Systems and Applications (SOS-B-PH303)													
	Program Outcomes								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5

CO1:	**2**		**1**	**3**		**2**	**2**	**1**	**1**	**2**	**1**	**1**	**1**
CO2:	**1**	**2**			**1**	**1**			**1**	**3**	**1**	**2**	**1**
CO3:	**2**		**1**	**2**		**1**	**1**	**2**			**2**	**2**	**2**
CO4:			**1**		**1**	**2**	**2**		**2**		**1**		
CO5:	**1**	**2**	**1**	**1**		**2**		**3**		**2**		**1**	**2**
CO6:	**2**		**3**	**1**	**2**	**1**	**2**		**1**	**2**	**1**	**3**	**1**
CO7:	**1**	**2**		**3**	**1**	**1**		**2**		**3**	**1**	**3**	**1**
CO8:	**2**	**1**	**1**		**2**		**1**	**1**	**1**	**1**			**1**

Note: 1: Low 2.: Moderate 3: High

DIGITAL SYSTEMS Lab (SOS-B-PH303)

Course Description:

The course involves experimental work related to the digital systems and applications, experiments such as Study of logic gates, verification of De Morgan's theorems, Half Adder, Full Adder and 4-bit binary Adder, build Flip-Flop, etc.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Experience of practical work related to digital electronics.
CO2	Gain knowledge of designing flip flop, adder, and subtrator.
CO3	Experimetal verification of De Morgan's theorems.
CO4	Build a 4-bit Counter using D-type/JK Flip-Flop ICs and study timing diagram.

Syllabus:

At least 06 experiments from the following:

1. Study of logic gates
2. Study of Boolean algebra

3. Verification of De Morgan's Theorems
4. Half Adder, Full Adder and 4-bit binary Adder.
5. Half Subtractor, Full Subtractor, Adder-Subtractor using Full Adder I.C.
6. To build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates.
7. To build JK Master-slave flip-flop using Flip-Flop ICs.
8. To build a 4-bit Counter using D-type/JK Flip-Flop ICs and study timing diagram.

CO-PO & PSO Correlation

Course Name : DIGITAL SYSTEMS Lab (SOS-B-PH303)													
	Program Outcomes								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:	3	2	3	1	2	1	2	2	2	2	3	2	1
CO2:	2	2	2	2	1	2	1	2	3	2	1	2	2
CO3:	2	3	2	1	3	2	3	2	2	1	3	1	2
CO4:	3	3	2	3	2	1	2	2	3	2	1	2	1

Note: Low 2.: Moderate 3: High

Programme: **B.Sc. (Hons) Physics** **Semester : IV Sem**

Name of the Course: **Waves and Optics** **Course Code: SOS-B-PH401**

Credits : 6 **No of Hours :**

Max Marks: 100

Course Description:

This course reviews the concepts of waves and optics learnt at school from a more advanced perspective and goes on to build new concepts. It begins with explaining ideas of superposition of harmonic oscillations leading to physics of travelling and standing waves. The course also provides an in depth understanding of wave phenomena of light, namely, interference and diffraction with emphasis on practical applications of the same.

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COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Understand simple harmonic oscillation and superposition principle; Different types of waves and their velocities.
CO2	Understand the concept of normal modes in transverse and longitudinal waves; Interference as superposition of waves from coherent sources.
CO3	Understand the basic concepts of Diffraction: Superposition of wavelets diffracted from aperture.
CO4	Understand the Fraunhoffer and Fresnel Diffraction
CO5	Study Wavelength of light using Newton Rings experiment, Fresnel Biprism, etc.
CO6	Resolve power of optical equipment; The motion of coupled oscillators and Lissajous figures.

Syllabus:

Superposition: Superposition of Two Collinear Harmonic oscillations: Simple harmonic motion (SHM). Linearity and Superposition Principle. (1) Oscillations having equal frequencies and (2) Oscillations having different frequencies (Beats). Superposition of Two Perpendicular Harmonic Oscillations: Graphical and Analytical Methods. Lissajous Figures (1:1 and 1:2) and their uses.

Waves Motion- General: Transverse waves on a string. Travelling and standing waves on a string. Normal Modes of a string. Group velocity, Phase velocity. Plane waves. Spherical waves, Wave intensity.

Sound: Sound waves, production and properties. Intensity and loudness of sound. Decibels. Intensity levels. musical notes. musical scale. Acoustics of buildings (General idea).

Wave Optics: Electromagnetic nature of light. Definition and Properties of wave front. Huygens Principle.

Interference: Interference: Division of amplitude and division of wavefront. Young's Double Slit experiment. Fresnel's Biprism. Phase change on reflection: Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: measurement of wavelength and refractive index.

Michelson's Interferometer: Construction and working. Idea of form of fringes (no theory needed), Determination of wavelength, Wavelength difference, Refractive index, and Visibility of fringes. Fabry-Perot interferometer.

Diffraction: Fraunhofer diffraction: Single slit; Double Slit. Multiple slits & Diffraction grating. Fresnel Diffraction: Half-period zones. Zone plate. Fresnel Diffraction pattern of a straight edge, a slit and a wire using half-period zone analysis.

Polarization: Transverse nature of light waves. Plane polarized light – production and analysis. Circular and elliptical polarization.

Reference Books:

1. Fundamentals of Optics, F.A Jenkins and H.E White, 1976, McGraw-Hill.
2. Principles of Optics, B.K. Mathur, 1995, Gopal Printing.
3. Fundamentals of Optics, A. Kumar, H.R. Gulati and D.R. Khanna, 2011, R. Chand Publications.
4. University Physics. F.W. Sears, M.W. Zemansky and H.D. Young. 13/e, 1986.Addison-Wesley.

CO-PO & PSO Correlation

Course Name : Waves and Optics (SOS-B-PH401)													
	Program Outcomes								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:	2	1		1		1	2	2	2		1	1	3
CO2:	3			1	3	2		1	1	2	2	1	1
CO3:	1	2	2		1	1	2	1		1	2	1	1
CO4:	2	1		1		1	2	2	2		1	1	3
CO5:		3	1	2	1	2		1	2	1	3		
CO6:	2		3	1	1		2		3	1	3	2	1

Note: 1: Low 2.: Moderate 3: High

OPTICS Lab (SOS-B-PH401)

Course Description:

The course involves practical work by students related to optics. Students need to do practicals such as determination of the wavelength of Laser light using Diffraction grating, wavelength of sodium light using Newton's Rings, refractive index of the Material of a prism using sodium source, etc.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Gain experience of practical work related to optics
CO2	Understand how to practically determine wavelength of sodium light using Newton's Rings.
CO3	Understand how to practically determine refractive index of the Material of a prism using sodium source.
CO4	Familiarization with: Schuster`s focusing; determination of angle of prism.

Syllabus:

At least 6 experiments from the list

1. To investigate the motion of coupled oscillators.
2. To study Lissajous Figures.
3. Familiarization with: Schuster`s focusing; determination of angle of prism.
4. To determine refractive index of the Material of a prism using sodium source.
5. To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.
6. To determine the wavelength of sodium source using Michelson's interferometer.
7. To determine wavelength of sodium light using Fresnel Biprism.
8. To determine wavelength of sodium light using Newton's Rings.
9. To determine the wavelength of Laser light using Diffraction grating.
10. To determine wavelength of (1) Sodium and (2) Mercury light using plane diffraction Grating

CO-PO & PSO Correlation

Course Name : OPTICS Lab (SOS-B-PH401)													
	Program Outcomes								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:	2	2	3	1	2	1	2	1	3	2	3	2	2
CO2:	3	3	2	2	1	2	1	2	3	2	1	2	2
CO3:	2	3	2	1	2	2	3	1	2	1	3	2	2
CO4:	2	3	3	3	2	1	2	2	2	2	1	2	1

Note: Low 2.: Moderate 3: High

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Department of Physics, School of Science

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UNIVERSITY OF STEEL TECHNOLOGY AND MANAGEMENT

Programme:	**B.Sc. (Hons) Physics**	**Semester :**	**IV Sem**
Name of the Course:	**Mathematical Physics – III**	**Course Code:**	**SOS-B-PH402**
Credits :	**6**	**No of Hours :**	
Max Marks:	**100**		

Course Description:

This course is aimed to provide an introduction to the theories for functions of a complex variable. It begins with the exploration of the algebraic, geometric and topological structures of the complex number field. The concepts of analyticity, Cauchy-Riemann relations and harmonic functions are then introduced. The notion of the Riemann sheet is presented to help student visualize multi-valued complex functions. Complex integration and complex power series are presented. We then discuss the classification of isolated singularities and examine the theory and illustrate the applications of the calculus of residues in the evaluation of integrals. Students will be equipped with the understanding of the fundamental concepts of complex variable theory. In particular, students will acquire the skill of contour integration to evaluate complicated real integrals via residue calculus. The prerequisites are some knowledge of calculus (up to line integrals and Green's theorem), and some basic familiarity with differential equations would be useful. The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Become familiar with the concepts Complex numbers.
CO2	Learn Properties and operations with Complex number.
CO3	Find domain and range of complex functions.
CO4	Evaluate limits and checking the continuity of complex function.
CO5	Check differentiability and Analyticity of functions.
CO6	Evaluate Complex integrals and applying Cauchy integral.

Syllabus:

Complex Analysis: Complex Numbers and their Graphical Representation. Euler's formula, De Moivre's theorem, Roots of Complex Numbers. Functions of Complex Variables. Analyticity and Cauchy-Riemann Conditions. Examples of analytic

functions. Integration of a function of a complex variable. Cauchy's Inequality. Cauchy's Integral formula. Simply and multiply connected region. Laurent and Taylor's expansion. Residues and Residue Theorem. Application in solving Definite Integrals.

Fourier Transforms: Fourier Integral theorem. Fourier Transform with examples. Fourier transform of trigonometric, Gaussian, finite wave train and other functions. Representation of Dirac delta function as a Fourier Integral. Fourier transform of derivatives, Inverse Fourier transform, Convolution theorem. Properties of Fourier transforms (translation, change of scale, complex conjugation, etc.). One dimensional Wave Equations, Dirac delta function, definition and properties.

Laplace Transforms: Laplace Transform (LT) of Elementary functions. Properties of LTs: Change of Scale Theorem, Shifting Theorem. LTs of 1st and 2nd order Derivatives and Integrals of Functions, Derivatives and Integrals of LTs. LT of Unit Step function, Dirac Delta function, Periodic Functions.

Dirac delta function: Definition and properties. Representation of Dirac delta function as a Fourier Integral. Laplace and Fourier Transform of Dirac delta function.

Reference Books:

1. K.F Riley, M.P. Hobson and S. J. Bence, Mathematical Methods for Physics and Engineers, 3rd ed., Cambridge University Press, 2006.
2. P.Dennery and A. Krzywicki ,Mathematics for Physicists, Dover Publications, 1967.
3. A.S.Fokas & M.J. Ablowitz, Complex Variables, 8th Ed., Cambridge Univ. Press , 2011.
4. A.K. Kapoor, Complex Variables, , Cambridge Univ. Press , 2014.
5. J.W. Brown & R.V. Churchill ,Complex Variables and Applications, , 7th Ed. , Tata McGraw-Hill , 2003.

CO-PO & PSO Correlation

Course Name : Mathematical Physics – III (SOS-B-PH402)													
	Program Outcomes								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:		1	1		2	1	2		1	2	2	2	1
CO2:		1	2	1	2	2		2	3	1	2		3
CO3:	2		1	1	3	1	2	3	2		1	2	2
CO4:	1	3	1	2	1	2		1	2	3	1	2	3
CO5:	2		3	1	1		2		3	1	3	1	2
CO6:	1	1		2		1	1	1	1			1	2

MATHEMATICAL PHYSICS-III Lab (SOS-B-PH402)

Course Description:

This course deals with C++/C/Scilab/Python based simulations experiments on Mathematical Physic.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Gain experience of C++/C/Scilab/Python based simulations experiments.
CO2	Understand to solve Boundary Value Problems using simulations.
CO3	Understand to solve differentiation and integration by simulation methods.
CO4	Solve typical mathematical problems such as Least square fitting, Fourier Transform of given function, etc.

Syllabus:

C++/C/Scilab/Python based simulations experiments on Mathematical Physics problems like

1. Boundary Value Problems:

A. Solution to Ordinary Differential equation (Boundary Value Problems using finite Difference and shooting methods):

(i) Solve $y''(x) + y(x) = 0$ with $y(0) = 1$, $y(\pi/2) = 1$ for $0<x<\pi$.

(ii) Solve for the steady state concentration profile y(x) in the reaction-diffusion problem given by Solve $y''(x) - y(x) = 0$ with $y(0)=1$, $y'(1) = 0$.

B. Solution to Partial Differential equation: Finite Difference and Crank-Nicholson methods to solve Laplace equation, wave equation, and Heat Equation.

2. Gauss Quadrature Integration Method : Gauss Legendre, Gauss Lagaurre and Gauss Hermite. :

(i). Verification of Orthogonality of Legendre Polynomials.

ii. Complex analysis: Integrate numerically using Gauss Laguerre method and check with contour integration.

3. Dirac Delta Function: representations of Dirac delta function as a limiting sequence of functions. Verify the properties of Dirac Delta function. e.g. Evaluate

, for $\sigma = 1, 0.1, 0.01$ and show that it tends to 5. Use Hermite Gauss quadrature method and also Simpson method with appropriate limits. 4. Fourier Series:

Evaluate the Fourier coefficients of a given periodic function (e.g. square wave, triangle wave, half wave and full wave rectifier etc.)

5. Weighted Least square fitting of given data (x,y) with known error/uncertainty-values using user defined function.
6. Integral transform:
i. Discrete and Fast Fourier Transform of given function in tabulated or mathematical form e.g function exp(-x2).
ii. Perform circuit analysis of a general LCR circuit using Laplace's transform.

CO-PO & PSO Correlation

Course Name : MATHEMATICAL PHYSICS-III Lab (SOS-B-PH402)													
	Program Outcomes								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:	2	3	2	1	2	2	2	1	2	3	3	1	3
CO2:	3	3	2	2	1	2	1	2	3	2	1	2	3
CO3:	2	3	2	1	2	3	3	1	2	1	3	2	2
CO4:	2	3	3	3	2	2	2	1	2	2	1	2	1

Note: Low 2.: Moderate 3: High

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Department of Physics, School of Science

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Programme:	**B.Sc. (Hons) Physics**	**Semester :**	**IV Sem**
Name of the Course:	**Elements of Modern Physics**	**Course Code:**	**SOS-B-PH403**
Credits :	**6**	**No of Hours :**	
Max Marks:	**100**		

Course Description:

The objective of this course is to teach the physical and mathematical foundations necessary for learning various topics in modern physics which are crucial for understanding atoms, molecules, photons, nuclei and elementary particles. These concepts are also important to understand phenomena in laser physics, condensed matter physics and astrophysics

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Learn inadequacies of classical mechanics and development of quantum mechanics; Formulation of Schrodinger equation.
CO2	Learn the idea of probability interpretation associated with wave-functions.
CO3	Learn the spontaneous and stimulated emission of radiation.
CO4	Understand the Optical pumping and population inversion; Three level and four level lasers, Ruby laser and He-Ne laser.
CO5	Understand the properties of nuclei, liquid drop model and nuclear shell model and mass formula.
CO6	Understand the decay rates and lifetime of radioactive decays like alpha, beta, gamma decay; Fission and fusion: Nuclear processes to produce nuclear energy in nuclear reactor.

Syllabus:

Basics of Quantum Physics: Planck's quantum, Planck's constant and light as a collection of photons; Blackbody Radiation: Quantum theory of Light; Photo-electric effect and Compton scattering. De Broglie wavelength and matter waves; Davisson-Germer experiment. Wave description of particles by wave packets. Group and Phase velocities and relation between them. Wave amplitude and wave functions.

One dimensional infinitely rigid box: energy eigen values, eigen functions and their normalization; Quantum dot as an example; Quantum mechanical scattering and

tunneling in one dimension : across a step potential & across a rectangular potential barrier.

Nucleus: Size and structure of atomic nucleus and its relation with atomic weight; Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle. Nature of nuclear force, N-Z raph, Liquid Drop model: semi-empirical mass formula and binding energy.

Radioactivity: stability of the nucleus; Law of radioactive decay; Mean life and half-life; Alpha decay; Beta decay: energy released, spectrum and Pauli's prediction of neutrino; Gamma ray emission, energy-momentum conservation: electron-positron pair creation by gamma photons in the vicinity of a nucleus. Fission and fusion: mass deficit, relativity and generation of energy; Fission: nature of fragments and emission of neutrons. Fusion and thermonuclear reactions driving stellar evolution (brief qualitative discussions).

Reference Books:

1. Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.

2. Modern Physics by R A Serway, C J Moses and C A Moyer, 3rd edition, Thomson Brooks Cole, 2012.

3. Modern Physics for Scientists and Engineers by S T Thornton and A Rex, 4th edition, Cengage Learning, 2013.

4. Concepts of Nuclear Physics by B L Cohen, Tata McGraw Hill Publication, 1974.

5. Quantum Mechanics, Robert Eisberg and Robert Resnick, 2ndEdn., 2002, Wiley.

6. Six Ideas that Shaped Physics: Particle Behave like Waves, T.A. Moore,2003, McGraw Hill.

7. New Physics, ed. Paul Davies, Cambridge University Press (1989).

8. Quantum Theory, David Bohm, Dover Publications, 1979.

9. Basic ideas and concepts in Nuclear Physics: A

CO-PO & PSO Correlation

Course Name : Elements of Modern Physics (SOS-B-PH403)													
	Program Outcomes								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:	1	2	1		1	1	1	2	2	2		3	2
CO2:	1	2	1	1	1			1	1	3	2	1	1
CO3:		1		2	2	1	1			1		2	
CO4:	1	2	1	1		1	2	2	2		1	1	3
CO5:	3	1	2		3	2		1	1	2	2	1	1
CO6:	2		3	1	1		2		3	1	3	1	2

Note: 1: Low 2.: Moderate 3: High

MODERN PHYSICS Lab (SOS-B-PH403)

Course Description:

The course deals with practical work related to modern physics.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Understand how to determine the Planck's constant using LEDs of at least 4 different colours.
CO2	Practically determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet.
CO3	Millikan oil drop apparatus and determine the charge of an electron.
CO4	Determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet.

Syllabus:

At least 5 experiments from the list

1. To determine the Planck's constant using LEDs of at least 4 different colours.
2. To determine the wavelength of H-alpha emission line of Hydrogen atom.
3. To determine the absorption lines in the rotational spectrum of Iodine vapour.
4. To determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet.
5. To setup the Millikan oil drop apparatus and determine the charge of an electron.
6. To show the tunneling effect in tunnel diode using I-V characteristics.
7. To determine the wavelength of laser source using diffraction of single slit.
8. To determine the wavelength of laser source using diffraction of double slits.
9. To determine angular spread of He-Ne laser using plane diffraction grating.

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CO-PO & PSO Correlation

Course Name : MODERN PHYSICS Lab (SOS-B-PH403)													
	Program Outcomes								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:	3	2	2	2	2	2	2	1	2	3	2	1	2
CO2:	3	3	2	2	1	2	1	1	3	2	1	2	3
CO3:	2	3	3	1	2	3	3	1	2	1	3	3	1
CO4:	2	3	3	2	2	2	2	1	2	2	1	2	1

Note: Low 2.: Moderate 3: High

Programme: **B.Sc. (Hons) Physics**
Name of the Course: **Applied Optics**
Credits : **2**
Max Marks: **100**

Semester : **IV Sem**
Course Code: **SOS-B-SEP302**
No of Hours :

Course Description:

The quest to understand the 'nature of light' is a favorite inquiry of mankind since ancient times. By the advent of lasers, holography, and optical fibres in twentieth century the optics now-a-days finds application in several branches of science and engineering. This paper provides the conceptual understanding of these branches of modern optics to the students. Theory includes only qualitative explanation. Minimum five experiments should be performed covering minimum three sections

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Learn the basic concepts of lasers.
CO2	Learn Holography.
CO3	Understand the Application Optical fibres in various sectors.
CO4	Understand the Fourier Optics and Fourier Transform Spectroscopy.

Syllabus:

Photo-sources and Detectors: Lasers: an introduction, Planck"s radiation law (qualitative idea), Energy levels, Absorption process, Spontaneous and stimulated emission processes, Theory of laser action, Population of energy levels, Einstein's coefficients and optical amplification, properties of laser beam, Ruby laser, He-Ne laser, and semiconductor lasers; Light Emitting Diode (LED) and photo-detectors.
Fourier Optics and Fourier Transform Spectroscopy (Qualitative explanation): Concept of Spatial frequency filtering, Fourier transforming property of a thin lens, Fourier Transform Spectroscopy (FTS): measuring emission and absorption spectra, with wide application in atmospheric remote sensing, NMR spectrometry, and forensic science.

Holography: Introduction, Basic principle and theory: recording and reconstruction processes, Requirements of holography-coherence, etc. Types of holograms: The thick or volume hologram, Multiplex hologram, white light reflection hologram; application of holography in microscopy, interferometry, and character recognition.

Photonics: Fibre Optics: Optical fibres: Introduction and historical remarks, Total Internal Reflection, Basic characteristics of the optical fibre: Principle of light propagation through a fibre, the coherent bundle, The numerical aperture, Attenuation in optical fibre and attenuation limit; Single mode and multimode fibres, Fibre optic sensors: Fibre Bragg

CO-PO & PSO Correlation

Course Name : Applied Optics (SOS-B-SEP302)													
	Program Outcomes								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:		1	2	2	1	2	2	2	3	2	1	1	2
CO2:	1		2	2	1	2	1		1	1		3	1
CO3:	1	1	1	1		1		2	2	1	1	2	2
CO4:	1	2		1		2		2	1	1	2	2	2

Note: 1: Low 2.: Moderate 3: High

APPLIED OPTICS Lab (SOS-B-SEP302)

Course Description:

The course deals with practical work related to modern physics Applied Optics.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Gain experiences of practical work related to applied optics.
CO2	Understand various experiments on lasers.
CO3	Understand various experiments on LED and photodetectors.
CO4	Understand various experiments on Fourier optics, holography, fiber optics, etc.

Syllabus:

Experiments on Lasers:

a. To determine the grating radial spacing of the Compact Disc (CD) by reflection using He-Ne or solid state laser.
b. To find the width of the wire or width of the slit using diffraction pattern obtained by a He-Ne or solid state laser.
c. To find the polarization angle of laser light using polarizer and analyzer
d. Thermal expansion of quartz using laser
e. To determine the wavelength and angular spread of laser light by using plane diffraction grating.

Experiments on Semiconductor Sources and Detectors:

a. V-I characteristics of LED
b. Study the characteristics of solid state laser
c. Study the characteristics of LDR
d. Characteristics of Photovoltaic Cell/ Photodiode.
e. Characteristics of IR sensor

Experiments on Fourier Optics:

a. Optical image addition/subtraction
b. Optical image differentiation
c. Fourier optical filtering
d. Construction of an optical 4f system

Experiments on Holography and interferometry:

a. Recording and reconstruction of holograms (Computer simulation can also be done).
b. To construct a Michelson interferometer or a Fabry Perot interferometer.
c. To determine the wavelength of sodium light by using Michelson"s interferometer.
d. To measure the refractive index of air.

Experiments on Fibre Optics

a. To measure the numerical aperture of an optical fibre
b. To measure the near field intensity profile of a fibre and study its refractive index profile
c. To study the variation of the bending loss in a multimode fibre
d. To determine the power loss at a splice between two multimode fibre
e. To determine the mode field diameter (MFD) of fundamental mode in a single-mode fibre by measurements of its far field Gaussian pattern

Reference Books:

1. LASERS: Fundamentals & applications, K.Thyagrajan& A.K.Ghatak, 2010, Tata McGraw Hill

2. Introduction to Fourier Optics, Joseph W. Goodman, The McGraw- Hill, 1996.

3. Introduction to Fiber Optics, A. Ghatak & K. Thyagarajan, Cambridge University Press.

4. Fibre optics through experiments, M.R.Shenoy, S.K.Khijwania, et.al. 2009, Viva Books

5. Optical Electronics, Ajoy Ghatak and K. Thyagarajan, 2011, Cambridge University Press

6. Optics, Karl Dieter Moller, Learning by computing with model examples, 2007, Springer.

7. Optoelectronic Devices and Systems, S.C. Gupta, 2005, PHI Learning Pvt. Ltd.

CO-PO & PSO Correlation

Course Name : APPLIED OPTICS Lab (SOS-B-SEP302)													
	Program Outcomes								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:	3	2	3	2	3	2	2	1	2	3	2	1	3
CO2:	3	3	2	2	1	2	1	1	3	2	1	2	3
CO3:	2	2	3	1	2	3	3	2	2	2	3	3	1
CO4:	2	3	3	2	3	2	2	2	2	3	1	2	2

Note: Low 2.: Moderate 3: High

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Department of Physics, School of Science

OPJU
UNIVERSITY OF STEEL TECHNOLOGY AND MANAGEMENT

Programme:	**B.Sc. (Hons) Physics**	**Semester :**	**IV Sem**
Name of the Course:	**Renewable Energy and Energy Harvesting**	**Course Code:**	**SOS-B-SEP303**
Credits :	**2**	**No of Hours :**	
Max Marks:	**100**		

Course Description:

The aim of this course is not just to impart theoretical knowledge to the students but to provide them with exposure and hands-on learning wherever possible.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Understandthe various forms of renewable energies.
CO2	Understand the Fossil fuels and Alternate Sources of energy.
CO3	Know the Solar energy: its importance and applications.
CO4	Know Wind Energy harvesting, Ocean Energy, Geothermal Energy, Hydro Energy.
CO5	Understand the Piezoelectric Energy and Electromagnetic Energy Harvesting.

Syllabus:

Fossil fuels and Alternate Sources of energy: Fossil fuels and nuclear energy, their limitation, need of renewable energy, non-conventional energy sources. An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity.

Solar energy: Solar energy, its importance, storage of solar energy, solar pond, non convective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems.

Wind Energy harvesting: Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies.

Ocean Energy: Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices.
Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass.

Geothermal Energy: Geothermal Resources, Geothermal Technologies.

Hydro Energy: Hydropower resources, hydropower technologies, environmental impact of hydro power sources.

Piezoelectric Energy harvesting: Introduction, Physics and characteristics of piezoelectric effect, materials and mathematical description of piezoelectricity, Piezoelectric parameters and modeling piezoelectric generators, Piezoelectric energy harvesting applications, Human power.

Electromagnetic Energy Harvesting: Linear generators, physics mathematical models, recent applications. Carbon captured technologies, cell, batteries, power consumption. Environmental issues and Renewable sources of energy, sustainability.

CO-PO & PSO Correlation

Course Name : Renewable Energy and Energy Harvesting (SOS-B SEP303)

	Program Outcomes								PSOs				
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1:	**1**	**2**		**1**	**1**	**2**	**1**	**2**	**2**	**2**	**3**	**2**	**1**
CO2:	**2**	**1**	**2**		**1**	**2**	**1**	**2**	**1**		**1**	**1**	
CO3:	**1**	**2**		**1**	**2**	**1**		**1**		**2**	**2**	**1**	**1**
CO4:	**1**		**1**	**1**		**1**		**2**		**2**	**1**	**1**	**2**
CO5:	**2**	**1**	**2**		**1**	**2**	**1**	**2**	**2**	**2**	**3**	**2**	**1**

Note: 1: Low 2.: Moderate 3: High

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Renewable Energy and Energy Harvesting Lab (SOS-B SEP303)

Course Description:

The course comprises the practical work related to Renewable Energy and Energy Harvesting that includes demonstration of Training modules on Solar energy, wind energy, etc. Conversion of vibration to voltage using piezoelectric materials
Conversion of thermal energy into voltage using thermoelectric modules

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Gain knowledge of modules on Solar energy.
CO2	Practically understand conversion of electricity from piezoelectric materials.
CO3	Understand practical realization of thermoelectric effect.
CO4	Understand how the wind energy is converted into electricity.

Syllabus:

1. Demonstration of Training modules on Solar energy, wind energy, etc.
2. Conversion of vibration to voltage using piezoelectric materials
3. Conversion of thermal energy into voltage using thermoelectric modules.

CO-PO & PSO Correlation

Course Name : Renewable Energy and Energy Harvesting Lab (SOS-B SEP303)

	Program Outcomes								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:	2	3	2	2	3	2	2	1	2	3	2	1	3
CO2:	3	3	2	3	2	3	2	1	2	2	1	2	2
CO3:	2	2	3	1	2	2	3	2	2	2	3	3	2
CO4:	2	3	3	2	3	2	2	2	2	3	2	2	3

Note: Low 2.: Moderate 3: High

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Programme:	**B.Sc. (Hons) Physics**	**Semester :**	**IV Sem**
Name of the Course:	**Physics Workshop Skill**	**Course Code:**	**SOS-B-SEP402**
Credits :	**2**	**No of Hours :**	
Max Marks:	**100**		

Course Description:

The aim of this course is to enable the students to familiar and experience with various mechanical and electrical tools through hands-on mode.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Use various instruments and building new devices.
CO2	Learn Skills to use mechanical systems.
CO3	Understand manufacturing methods: casting, foundry, machining, forming and welding.

Syllabus:

Introduction: Measuring devices: Vernier calliper, Screw gauge and travelling microscope. Measure the dimension of a solid block, volume of cylindrical beaker/glass, diameter of a thin wire, thickness of metal sheet, etc. Use of Sextant to measure height of buildings, mountains, etc.

Mechanical Skill: Overview of manufacturing methods: casting, foundry, machining, forming and welding. Types of welding joints and welding defects. Concept of machine processing, introduction to common machine tools like lathe, shaper, drilling, milling and surface machines. Cutting tools, lubricating oils. Cutting of a metal sheet using blade. Smoothening of cutting edge of sheet using file. Drilling of holes of different diameter in metal sheet and wooden block. Use of bench vice and tools for fitting. Make funnel using metal sheet.

Introduction to prime movers: Mechanism, gear system, wheel, Fixing of gears with motor axel. Lever mechanism, Lifting of heavy weight using lever. braking systems,

pulleys, working principle of power generation systems. Demonstration of pulley experiment.

Reference Books:

1. A text book in Electrical Technology - B L Theraja – S. Chand and Company.

2. Performance and design of AC machines – M.G. Say, ELBS Edn.

3. Mechanical workshop practice, K.C. John, 2010, PHI Learning Pvt. Ltd.

4. Workshop Processes, Practices and Materials, Bruce J Black 2005, 3rd Edn., Editor Newnes [ISBN: 0750660732]

5. New Engineering Technology, Lawrence Smyth/Liam Hennessy, The Educational Company of Ireland [ISBN: 0861674480]

CO-PO & PSO Correlation

Course Name : Physics Workshop Skill (SOS-B-SEP402)													
	Program Outcomes								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:	1	1		1	1	2	1	2	2	2	3	2	1
CO2:	2	2	2		1	2	1	2	1		1	1	
CO3:	2		2	1		2	2	2	3	2	1		1

Note: 1: Low 2.: Moderate 3: High

Programme:	**B.Sc. (Hons) Physics**	**Semester :**	**IV Sem**
Name of the Course:	**Electrical Circuits and Network Skills**	**Course Code:**	**SOS-B-SEP403**
Credits :	**2**	**No of Hours :**	
Max Marks:	**100**		

Course Description:

The aim of this course is to enable the students to design and trouble shoots the electrical circuits, networks and appliances through hands-on mode.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Get expertise in designing and trouble shoots the electrical circuits.
CO2	Learn Networks and appliances through hands-on mode.
CO3	Learn about Generators, transformers, electric motors, solid-state devices.
CO4	Learn and use of Electrical protection, electrical wiring.
CO5	Understand the Network theorems.

Syllabus:

Basic Electricity Principles: Voltage, Current, Resistance, and Power. Ohm's law.Series, parallel, and series-parallel combinations. AC and DC Electricity. Familiarization with multimeter, voltmeter and ammeter.

Electrical Circuits: Basic electric circuit elements and their combination. Rules to analyze DC sourced electrical circuits. Current and voltage drop across the DC circuit elements. Single-phase and three-phase alternating current sources. Rules to analyze AC sourced electrical circuits. Real, imaginary and complex power components of AC source. Power factor. Saving energy and money.

Electrical Drawing and Symbols:
Drawing symbols. Blueprints. Reading Schematics. Ladder diagrams. Electrical Schematics. Power circuits. Control circuits. Reading of circuit schematics. Tracking the connections of elements and identify current flow and voltage drop.

Generators and Transformers: DC Power sources. AC/DC generators. Inductance, capacitance, and impedance.Operation of transformers.

Electric Motors: Single-phase, three-phase & DC motors. Basic design. Interfacing DC or AC sources to control heaters and motors. Speed & power of ac motor.

Solid-State Devices: Resistors, inductors and capacitors. Diode and rectifiers. Components in Series or in shunt. Response of inductors and capacitors with DC or AC sources.

Electrical Protection: Relays. Fuses and disconnect switches. Circuit breakers. Overload devices. Ground-fault protection. Grounding and isolating. Phase reversal. Surge protection. Relay protection device.

Electrical Wiring: Different types of conductors and cables. Basics of wiring-Star and delta connection. Voltage drop and losses across cables and conductors. Instruments to measure current, voltage, power in DC and AC circuits. Insulation. Solid and stranded cable. Conduit. Cable trays. Splices: wirenuts, crimps, terminal blocks, and solder. Preparation of extension board.

Network Theorems: (1) Thevenin theorem (2) Norton theorem (3) Superposition theorem (4) Maximum Power Transfer theorem.

Reference Books:

1. Electrical Circuits, K.A. Smith and R.E. Alley, 2014, Cambridge University Press

2. A text book in Electrical Technology - B L Theraja - S Chand & Co.

3. A text book of Electrical Technology - A K Theraja

4. Performance and design of AC machines - M G Say ELBS Edn.

CO-PO & PSO Correlation

Course Name : Electrical Circuits and Network Skills (SOS-B-SEP403)													
	Program Outcomes								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:	1	2	2	1	2	2	1	2	2	2	2	1	2
CO2:	1	2	1		2	2	1	2	1	2	1	2	2
CO3:	2	2	1	1	1	1	2	1	2	2	1	1	1
CO4:	2	2	1	2	2	1	2	2	2	2	1	2	2
CO5:	1	2	2	1	2	2	1	2	2	2	2	1	2

Note: 1: Low 2.: Moderate 3: High

ELECTRICAL CIRCUITS AND NETWORK SKILLS Lab (SOS-B-SEP403)

Course Description:

The course comprises the practical work related electrical circuits and network skills.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome

CO1	Gain practical knowledge of Kirchoff"s law.
CO2	Practically understand study frequency response curve of a Series LCR circuit.
CO3	Understand practical realization of Faraday's law and Lenz's law.
CO4	Understand practical realization of diode, transformer, generator, regulated power supply, preparation of extension board with MCB/fuse, switch, socket-plug, Indicator.

Syllabus:

1. Series and Parallel combinations: Verification of Kirchoff"s law.
2. To verify network theorems: (I) Thevenin (II) Norton (III) Superposition theorem (IV) Maximum power transfer theorem
3. To study frequency response curve of a Series LCR circuit.
4. To verify (1) Faraday's law and (2) Lenz's law.
5. Programming with Pspice/NG spice.
6. Demonstration of AC and DC generator.
7. Speed of motor
8. To study the characteristics of a diode.
9. To study rectifiers (I) Half wave (II) Full wave rectifier (III) Bridge rectifier
10. Power supply (I) C-filter, (II) π- filter
11. Transformer – Step up and Step down
12. Preparation of extension board with MCB/fuse, switch, socket-plug, Indicator.
13. Fabrication of Regulated power supply.

Reference Books:

1. Electrical Circuits, K.A. Smith and R.E. Alley, 2014, Cambridge University Press

2. A text book in Electrical Technology - B L Theraja - S Chand & Co.

3. A text book of Electrical Technology - A K Theraja

4. Performance and design of AC machines - M G Say ELBS Edn.

CO-PO & PSO Correlation

Course Name : ELECTRICAL CIRCUITS AND NETWORK SKILLS Lab (SOS-B-SEP403)

	Program Outcomes								PSOs				
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1:	**2**	**3**	**2**	**2**	**2**	**3**	**1**	**1**	**3**	**3**	**3**	**2**	**3**
CO2:	**3**	**2**	**3**	**3**	**3**	**3**	**2**	**1**	**2**	**2**	**2**	**2**	**2**
CO3:	**2**	**2**	**3**	**1**	**2**	**2**	**3**	**2**	**3**	**3**	**3**	**3**	**2**
CO4:	**2**	**3**	**3**	**2**	**3**	**2**	**2**	**1**	**2**	**3**	**2**	**2**	**3**

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Programme:	**B.Sc. (Hons) Physics**	**Semester :**	**IV Sem**
Name of the Course:	**Basic Instrumentation Skills**	**Course Code:**	**SOS-B-SEP404**
Credits :	**2**	**No of Hours :**	
Max Marks:	**100**		

Course Description:

This course is to get exposure with various aspects of instruments and their usage through hands-on mode. Experiments listed below are to be done in continuation of the topics.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Understand thebasics of instrumental measurements.
CO2	Use Voltmeter, multimeter, signal and pulse generators, and oscilloscope.
CO3	Learn Instruments accuracy, precision, sensitivity.
CO4	Explain Resolution range, errors in measurements and loading effects.

Syllabus:

Basic of Measurement: Instruments accuracy, precision, sensitivity, resolution range etc. Errors in measurements and loading effects.

Multimeter: Principles of measurement of dc voltage and dc current, ac voltage, ac current and resistance. Specifications of a multimeter and their significance.

Electronic Voltmeter: Advantage over conventional multimeter for voltage measurement with respect to input impedance and sensitivity. Principles of voltage, measurement (block diagram only). Specifications of an electronic Voltmeter/Multimeter and their significance.

AC millivoltmeter: Type of AC millivoltmeters. Block diagram ac millivoltmeter**,** specifications and their significance.

Oscilloscope: Block diagram of basic CRO. CRT, electrostatic focusing and acceleration (Explanation only–no mathematical treatment), brief discussion on screen phosphor, visual persistence. Time base operation, synchronization.Front panel controls. Specifications of CRO and their significance. Use of CRO for the measurement of voltage (dc and ac), frequency and time period. Special features of dual trace, introduction to digital oscilloscope, probes. Digital storage Oscilloscope: principle of working.

Signal and pulse Generators: Block diagram, explanation and specifications of low frequency signal generator and pulse generator. Brief idea for testing, specifications. Distortion factor meter, wave analysis.

Impedance Bridges: Block diagram of bridge.working principles of basic (balancing type) RLC bridge. Specifications of RLC bridge. Block diagram and working principles of a Q-meter. Digital LCR bridges.

Digital Instruments: Comparison of analog & digital instruments. Characteristics of a digital meter. Working principles of digital voltmeter.

Impedance Bridges: Block diagram of bridge.working principles of basic (balancing type) RLC bridge. Specifications of RLC bridge. Block diagram and working principles of a Q-Meter. Digital LCR bridges.

Digital Instruments: Comparison of analog & digital instruments. Characteristics of a digital meter. Working principles of digital voltmeter.

Digital Multimeter: Block diagram and working of a digital multimeter. Working principle of time interval, frequency and period measurement using universal counter/frequency counter, time- base stability, accuracy and resolution.

PRACTICAL

1. To observe the loading effect of a multimeter while measuring voltage across a low resistance and high resistance.
2. To observe the limitations of a multimeter for measuring high frequency voltage and currents.
3. To measure Q of a coil and its dependence on frequency, using a Q- meter.
4. Measurement of voltage, frequency, time period and phase using Oscilloscope.
5. Measurement of time period, frequency, average period using universal counter/ frequency counter.
6. Measurement of rise, fall and delay times using a Oscilloscope.
7. Measurement of distortion of a RF signal generator using distortion factor meter.
8. Measurement of R,L and C using a LCR bridge/ universal bridge.

Reference Books:

1. A text book in Electrical Technology - B L Theraja - S Chand and Co.

2. Performance and design of AC machines - M G Say ELBS Edn.

3. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.

4. Logic circuit design, Shimon P. Vingron, 2012, Springer.

5. Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.

6. Electronic Devices and circuits, S. Salivahanan & N. S.Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill

CO-PO & PSO Correlation

Course Name : Basic Instrumentation Skills (SOS-B-SEP404)													
	Program Outcomes								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:	1	2	2	2	1	2	2	1	2	2	2	1	2
CO2:	1	2	1	1	1	2	2	1	2	1	1	3	1
CO3:	2	1	2	2	1	2	1	2	1	2	2	1	2
CO4:	1	2	2	2	1	2	1	1	2	2	2	1	2

Note: 1: Low 2.: Moderate 3: High

BASIC INSTRUMENTATION SKILLS Lab (SOS-B-SEP404)

Course Description:
The course comprises the practical work related basic instrumentation skills.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Gain practical knowledge loading effect of a multimeter.
CO2	Practically understand how to measure Q of a coil.
CO3	Understand practical realization .
CO4	Practically measure voltage, frequency, time period and phase using Oscilloscope.

Syllabus:

1. To observe the loading effect of a multimeter while measuring voltage across a low resistance and high resistance.
2. To observe the limitations of a multimeter for measuring high frequency voltage and currents.
3. To measure Q of a coil and its dependence on frequency, using a Q- meter.
4. Measurement of voltage, frequency, time period and phase using Oscilloscope.
5. Measurement of time period, frequency, average period using universal counter/ frequency counter.
6. Measurement of rise, fall and delay times using a Oscilloscope.
7. Measurement of distortion of a RF signal generator using distortion factor meter.
8. Measurement of R,L and C using a LCR bridge/ universal bridge.

Reference Books:

1. A text book in Electrical Technology - B L Theraja - S Chand and Co.

2. Performance and design of AC machines - M G Say ELBS Edn.

3. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.

4. Logic circuit design, Shimon P. Vingron, 2012, Springer.

5. Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.

6. Electronic Devices and circuits, S. Salivahanan & N. S.Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill

CO-PO & PSO Correlation

Course Name : BASIC INSTRUMENTATION SKILLS Lab (SOS-B-SEP404)

	Program Outcomes								PSOs				
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1:	**2**	**3**	**2**	**3**	**2**	**3**	**2**	**1**	**3**	**2**	**3**	**1**	**2**
CO2:	**3**	**2**	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**2**
CO3:	**3**	**2**	**3**	**1**	**2**	**2**	**3**	**1**	**3**	**3**	**3**	**3**	**2**
CO4:	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**2**	**2**	**3**	**2**	**2**	**2**

Note: 1: Low 2.: Moderate 3: High

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Programme:	**B.Sc. (Hons) Physics**	**Semester :**	**V Sem**
Name of the Course:	**Quantum Mechanics and Applications**	**Course Code:**	**SOS-B-PH501**
Credits :	**6**	**No of Hours :**	
Max Marks:	**100**		

Course Description:

After learning the elements of modern physics, in this course students would be exposed to more advanced concepts in quantum physics and their applications to problems of the sub atomic world.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Understand the Methods to solve time-dependent and time-independent Schrodinger equation.; Quantum mechanics of simple harmonic oscillator.
CO2	Understand the Non-relativistic hydrogen atom: spectrum and eigen functions.
CO3	Understand the Angular momentum: Orbital angular momentum and spin angular momentum.
CO4	Know the Application to atomic systems; the Expectation values of position and momentum.
CO5	Understand the Spin-orbit coupling: L-S and J-J couplings with examples.
CO6	Solve the Schrodinger equation for ground state energy and wave functions of various simple quantum mechanical one- dimensional and three dimensional potentials.

Syllabus:

Foundation of Quantum Mechanics: Inadequancy of classical mechanics, Planck's law of blackbody radiation, Photoelectric effect, de Broglie hypothesis, Wave-particle

duality, Davisson-Germer experiment, Wave packets, Group velocity and phase velocity, Uncertainty principle.

Wave Mechanics: Time dependent and time independent Schrödinger equations, physical significance of wave function, Conditions for Physical Acceptability of Wave Functions and probability current density, Normalization of wave fuction, Eigenvalues and Eigenfunctions. Position, momentum and Energy operators, Expectation values of position and momentum. Ehrenfest's theorem.

Application of Schrödinger equation: Particle in an infinite well potential, particle in a finite well potential, rectangular potential barrier and tunneling, Linear harmonic oscillator, Angular momentum operators and their eigen functions, Hydrogen atom.

Multi Electron Atoms: Pauli's Exclusion Principle and Symmetric and Antisymmetric Wave Functions, concept of Spin orbit coupling and different Spectral Notations for Atomic States. Total angular momentum. Spin-orbit coupling: L-S and J-J couplings with examples.

BOOKS FOR REFERENCES:

1. Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn., 2002, Wiley.
2. Quantum Mechanics, Leonard I. Schiff, 3rd Edn. 2010, Tata McGraw Hill.
3. Quantum Mechanics for Scientists & Engineers, D.A.B. Miller, 2008, Cambridge University Press
4. Quantum Mechanics: B. H. Bransden and C. J. Joachain.
5. Quantum Physics of Atoms, Molecules, Nuclei and Solids: R. M. Eisberg and R. Resnick.
6. Schaum's outline of Programming with C++. J. Hubbard, 2000, McGraw-Hill Publication
7. An introduction to computational Physics, T. Pang, 2nd Edn.,2006, Cambridge Univ. Press Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific & Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández.2014 Springer.
8. Scilab (A Free Software to Matlab): H. Ramchandran, A.S. Nair. 2011 S. Chand & Co.
9. A Guide to MATLAB, B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, 2014, 3rd Edn., Cambridge University Press

CO-PO & PSO Correlation

Course Name : Quantum Mechanics and Applications (SOS-B-PH501)													
	Program Outcomes								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:	2	1	1		1	1		1		1	1	1	2
CO2:		2	1	2		1	2		1	3		2	1
CO3:	2	1	3	2	1	1		2	2	2	1	1	
CO4:	1				2	2			1		1	2	2
CO5:	2	2	2	3	1		2	1		3	2		1
CO6:	1		2	1		2	2	1	1		1	2	2

Note: 1: Low 2.: Moderate 3: High

QUANTUM MECHANICS Lab (SOS-B-PH501)

Course Description:

The course comprises the practical work related to quantum mechanics.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Gain practical knowledge programming languages C/C++/Python.
CO2	Practically understand how to solve the s-wave Schrodinger equation.
CO3	Obtain the energy eigenvalues and plot the corresponding wavefunctions
CO4	Practically solve the s-wave radial Schrodinger equation for an atom.

Syllabus:

Use C/C++/Scilab/Python for solving the following problems based on Quantum Mechanics like:

1. Solve the s-wave Schrodinger equation for the ground state and the first excited state of the hydrogen atom:

   $\frac{d^2y}{dr^2} = A(r)u(r), A(r) = (2m/\hbar^2)$ [V (r)-E], where V(r) = $-e^2/r$

   where m is the reduced mass of the electron. Obtain the energy eigenvalues and plot the corresponding wavefunctions. Remember that the ground state energy of the hydrogen atom is ≈ -13.6 eV. Take e = 3.795 (eVÅ)1/2, ħc = 1973 (eVÅ) and m = 0.511x106 eV/c^2.

2. Solve the s-wave radial Schrodinger equation for an atom:

   $\frac{d^2y}{dr^2} = A(r)u(r), A(r) = (2m/\hbar^2)$ [V (r)-E], where V(r) = $(-e^2/r)\, e^{-r/a}$

   Find the energy (in eV) of the ground state of the atom to an accuracy of three significant digits. Also, plot the corresponding wavefunction. Take e = 3.795 $(eVÅ)^{1/2}$, m = $0.511x10^6$ eV/c^2, and a = 3 Å, 5 Å, 7 Å. In these units ħc = 1973 (eVÅ). The ground state energy is expected to be above -12 eV in all three cases.

CO-PO & PSO Correlation

Course Name : QUANTUM MECHANICS Lab (SOS-B-PH501)

	Program Outcomes								PSOs				
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1:	**2**	**3**	**2**	**2**	**2**	**2**	**2**	**1**	**3**	**2**	**2**	**2**	**2**
CO2:	**2**	**2**	**2**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**2**
CO3:	**2**	**2**	**3**	**1**	**2**	**2**	**2**	**1**	**3**	**3**	**2**	**2**	**3**
CO4:	**2**	**1**	**3**	**2**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**

Note: 1: Low 2.: Moderate 3: High

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UNIVERSITY OF STEEL TECHNOLOGY AND MANAGEMENT

Programme: **B.Sc. (Hons) Physics** **Semester :** **V Sem**

Name of the Course: **Solid State Physics** **Course Code:** **SOS-B-PH502**

Credits : **6** **No of Hours :**

Max Marks: **100**

Course Description:

This course introduces the basic concepts and principles required to understand the various properties exhibited by condensed matter, especially solids. It enables the students to appreciate how the interesting and wonderful properties exhibited by matter depend upon its atomic and molecular constituents. The gained knowledge helps to solve problems in solid state physics using relevant mathematical tools. It also communicates the importance of solid state physics in modern society.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Elucidate the concept of lattice, crystals and symmetry operations.
CO2	Understand the elementary lattice dynamics and its influence on the properties of materials.
CO3	Describe the main features of the physics of electrons in solids: origin of energy bands, and their influence electronic behavior.
CO4	Explain the origin of dia-, para-, and ferro-magnetic properties of solids.
CO5	Explain the origin of the dielectric properties exhibited by solids and the concept of polarisability.
CO6	Understand the basics of phase transitions and the preliminary concept and experiments related to superconductivity in solid.
CO7	Learn how to measure the magnetic susceptibility, dielectric constant, trace hysteresis loop.
CO8	Employ four probe methods to measure electrical conductivity and the hall set up to determine the hall coefficient of a semiconductor.

Syllabus:

Crystal Structure: Classification of Solid as crystalline and amorphous materials with examples, Unit cell, Lattice Translation Vectors. Miller Indices, Types of Lattices. Common crystal structures: NaCl, CsCl, ZnS and Diamond, Brillouin Zones. Diffraction of X-rays and Bragg's Law, Atomic and Geometrical Factor.

Band Theory of Solid: Nearly Free Electron Model, Kronig Penny model, Energy Band Gap. Conductor, Semiconductor and Insulator. Conductivity of Semiconductor, concept of effective mass and mobility of electron and holes, Effect of Temperature, Hall Effect.

Lattice Vibrations: Vibrational modes of continuous medium, Density of states, Einstein's and Debye's theory of specific heat, Vibrations of one dimensional monoatomic and diatomic chain, Phonons.

Magnetic Properties of Solids: Basic concept, orbital and spin magnetic moments, Bohr magnetron, Dia-, Para-, Ferro, Antiferro and Ferrimagnetic Materials, Classical Langevin Theory of dia– and Paramagnetic materials, Quantum Mechanical Theory of Paramagnetism. Curie's law, Ferromagnetic Domains and Molecular Weiss's Theory, B-H Curve and Energy Loss.

Superconductivity: Physical behaviors of superconductors and normal metals, Different Properties of Superconductors: Critical Temperature, Critical magnetic field, Isotope Effect and Meissner effect. Type I and type II Superconductors, London's Equations, BCS theory.

BOOKS FOR REFERENCES:

1. Introduction to Solid State Physics, Charles Kittel, 8th Edn., 2004, Wiley India Pvt. Ltd.
2. Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill.
3. Solid State Physics, M.A. Wahab, 2011, Narosa Publications.
4. Solids State Physics: Decker.
5. Solid State Physics: An Introduction to principles of Materials Science: H. Ibach & H. Luth (Springer).
6. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
7. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal

8. Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India
9. Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press
10. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.

CO-PO & PSO Correlation

Course Name : Solid State Physics (SOS-B-PH502)													
	Program Outcomes								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:	1		1	1	1		1	2	1	1	1	2	1
CO2:		1	3		1	2			2	1	3	2	2
CO3:	2	2	2	1	3	2	1	2	1	3			2
CO4:		1		1			2	1			1	2	
CO5:	1		3	2	2	3	1	2	2	2		1	2
CO6:	1	1		1	2	1		1	1	2	3	1	2
CO7:	1		1	1	1	1		2	3	2	1	3	1
CO8:	2	1	3	1	2	3	1	2	1		2	2	2

Note: 1: Low 2.: Moderate 3: High

SOLID STATE PHYSICS Lab (SOS-B-PH502)

Course Description:
The course comprises the practical work related to Solid State Physics.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Gain practical knowledge to determine the area of loop by universal B-H curve tracer.

CO2	Practically understand how to measure the resistivity of a semiconductor with temperature by four-probe method and determine its band gap.
CO3	Practically determine the Hall coefficient of a semiconductor sample.
CO4	Practical experiences of band gap determination, measurement of magnetic and structural properties of materials.

Syllabus:

1. To determine the area of loop by universal B-H curve tracer.
2. To measure the resistivity of a semiconductor with temperature by four-probe method and determine its band gap.
3. To determine the Hall coefficient of a semiconductor sample.
4. Analysis of X-Ray diffraction data in terms of unit cell parameters and estimation of particle size.
5. Measurement of change in resistance of a semiconductor with magnetic field.
6. To determine the *band gap* in a *semiconductor* using its p-n junction diode.
7. Measurement of susceptibility of paramagnetic solution (Quinck's Tube Method).

CO-PO & PSO Correlation

Course Name : SOLID STATE PHYSICS Lab (SOS-B-PH502)

	Program Outcomes								PSOs				
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1:	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**1**	**3**	**2**	**2**	**2**	**3**
CO2:	**2**	**2**	**2**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**2**
CO3:	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**1**	**3**	**3**	**2**	**2**	**3**
CO4:	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**

Note: 1: Low 2.: Moderate 3: High

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Programme:	**B.Sc. (Hons) Physics**	**Semester :**	**VI Sem**
Name of the Course:	**Electromagnetic Theory**	**Course Code:**	**SOS-B-PH601**
Credits :	**6**	**No of Hours :**	
Max Marks:	**100**		

Course Description:

Introduction to basic mathematical concepts related to electromagnetic vector fields, knowledge on the concepts of electrostatics, electric potential, energy density and their applications. Focus on the concepts of magneto statics, magnetic flux density, scalar and vector potential, Faraday's law, induced e.m.f and Maxwell's equations, electromagnetic waves and Transmission lines and its applications.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Apply Maxwell's equations to deduce wave equation, electromagnetic field energy, momentum and angular momentum density.
CO2	Understand electromagnetic wave propagation in unbounded media: Vacuum, dielectric medium, conducting medium, plasma.
CO3	Understand electromagnetic wave propagation in bounded media: reflection and transmission coefficients at plane interface in bounded media.
CO4	Understand polarization of Electromagnetic Waves: Linear, Circular and Elliptical Polarization. Production as well as detection of waves in laboratory.
CO5	Learn the features of planar optical wave guide.
CO6	Application of Maxwell's equations to find the solutions of problems relating to transmission lines and uniform plane wave propagation.

Syllabus:

Maxwell Equations: Review of Maxwell's equations. Displacement Current. Vector and Scalar Potentials. Gauge Transformations: Lorentz and Coulomb Gauge. Boundary

Conditions at Interface between Different Media. Wave Equations. Plane Waves in Dielectric Media. Poynting Theorem and Poynting Vector. Electromagnetic (EM) Energy Density. Physical Concept of Electromagnetic Field Energy Density.

EM Wave Propagation in Unbounded Media: Plane EM waves through vacuum and isotropic dielectric medium, transverse nature of plane EM waves, refractive index and dielectric constant, wave impedance. Propagation through conducting media, relaxation time, skin depth. Wave propagation through dilute plasma, electrical conductivity of ionized gases, plasma frequency, refractive index.

EM Wave in Bounded Media: Boundary conditions at a plane interface between two media. Reflection & Refraction of plane waves at plane interface between two dielectric Media-Laws of Reflection & Refraction. Fresnel's Formulae for perpendicular & parallel polarization cases, Brewster's law. Reflection & Transmission coefficients. Total internal reflection.

Polarization of Electromagnetic Waves: Description of Linear, Circular and Elliptical Polarization. Propagation of E.M. Waves in Anisotropic Media. Symmetric Nature of Dielectric Tensor. Fresnel's Formula. Uniaxial and Biaxial Crystals. Light Propagation in Uniaxial Crystal.

Wave Guides: Planar optical wave guides. Planar dielectric wave guide ($-d/2 < x < d/2$). Condition of continuity at interface. Phase shift on total reflection. Eigenvalue equations. Phase and group velocity of guided waves. Field energy and Power transmission.

Optical Fibres: Acceptance Angle, Numerical Aperture. Step and Graded Indices (Definitions Only). Single and Multiple Mode Fibres.

BOOKS FOR REFERENCES:

1. D.J. Griffiths, Introduction to Electrodynamics, 3rd Ed.,Benjamin Cummings, 1998.
2. M.N.O. Sadiku, Elements of Electromagnetics, Oxford University Press , 2001.
3. M.A.W. Miah, Fundamentals of Electromagnetics,Tata McGraw Hill , 1982.
4. R.S. Kshetrimayun, Electromagnetic field Theory, Cengage Learning , 2012.

CO-PO & PSO Correlation

Course Name : Electromagnetic Theory (SOS-B-PH601)													
	Program Outcomes								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:	1		2	1	2	2	1	3	2	1	2	1	3
CO2:	2	1	2	2	1		1			2	1		
CO3:	1	1	3	1		3	2	2	3	1	2	2	2
CO4:	1	2	1	2	1		1	2	1		1	1	2
CO5:	3	1	1			1	1	1	1		2	3	2
CO6:		2		1	1	3	1	2	3	1	2	1	

Note: 1: Low 2.: Moderate 3: High

ELECTROMAGNETIC THEORY Lab (SOS-B-PH601)

Course Description:

The course comprises the practical work related to electromagnetic theory.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Gain practical knowledge to verify verify the law of Malus for plane polarized light.
CO2	Practically understand how to measure the specific rotation of sugar solution using Polarimeter.
CO3	Practically study reflection, refraction of microwaves.
CO4	Practically find Numerical Aperture of an Optical Fibre, Brewster's angle, Stefan's constant, etc.

Syllabus:

At least 06 experiments from the following

1. To verify the law of Malus for plane polarized light.
2. To determine the specific rotation of sugar solution using Polarimeter.

3. To analyze elliptically polarized Light by using a Babinet's compensator.
4. To study dependence of radiation on angle for a simple Dipole antenna.
5. To study the reflection, refraction of microwaves
6. To study Polarization and double slit interference in microwaves.
7. To study the polarization of light by reflection and determine the polarizing angle for air-glass interface.
8. To verify the Stefan`s law of radiation and to determine Stefan's constant.
9. To determine Boltzmann constant using V-I characteristics of PN junction diode.
10. To find Numerical Aperture of an Optical Fibre.
11. To verify Brewster's Law and to find the Brewster's angle.

CO-PO & PSO Correlation

Course Name : ELECTROMAGNETIC THEORY Lab (SOS-B-PH601)

	Program Outcomes								PSOs				
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1:	**3**	**3**	**2**	**3**	**2**	**3**	**2**	**1**	**3**	**2**	**2**	**2**	**3**
CO2:	**2**	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**2**
CO3:	**3**	**3**	**3**	**2**	**2**	**2**	**3**	**1**	**3**	**3**	**2**	**3**	**3**
CO4:	**2**	**2**	**2**	**2**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**

Note: 1: Low 2.: Moderate 3: High

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Department of Physics, School of Science

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Programme:	**B.Sc. (Hons) Physics**	**Semester :**	**VI Sem**
Name of the Course:	**Statistical Mechanics**	**Course Code:**	**SOS-B-PH602**
Credits :	**6**	**No of Hours :**	
Max Marks:	**100**		

Course Description:

Statistical Mechanics deals with the derivation of the macroscopic parameters (internal energy, pressure, specific heat etc.) of a physical system consisting of large number of particles (solid, liquid or gas) from knowledge of the underlying microscopic behavior of atoms and molecules that comprises it. The main objective of this course work is to introduce the techniques of Statistical Mechanics which has applications in various fields including Astrophysics, Semiconductors, Plasma Physics, Bio-Physics etc. and in many other directions.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Understand the concepts of microstate, macro-state, phase space, thermodynamic probability and partition function.
CO2	Understand the elementary lattice dynamics and its influence on the properties of materials.
CO3	Understand the properties and Laws associated with thermal radiation.
CO4	Apply the Fermi- Dirac distribution to model problems such as electrons in solids and white dwarf stars.
CO5	Apply the Bose-Einstein distribution to model problems such as blackbody radiation and Helium gas of polarisability.
CO6	Perform numerical simulations for solving the problems based on Statistical Mechanics.

Syllabus:

Basics of Statistical Mechanics: State of a system (Microscopic and Macroscopic); Phase space, density of states and Liouville's theorem; Postulates of statistical mechanics; Relation between statistical and thermodynamic parameters.

Classical Statistics: Macrostates and Microstates, Phase Space, Entropy and Thermodynamic Probability, Maxwell-Boltzmann Distribution Law, Partition Function, Thermodynamic Functions of an Ideal Gas, Classical Entropy Expression, Gibbs Paradox, Law of Equipartition of Energy, Applications to Specific Heat of gas and solids and its Limitations.

Bose-Einstein Statistics: B-E Distribution law, Thermodynamic functions of a strongly degenerate Bose Gas, Bose Einstein condensation, properties of liquid He (qualitative description), Radiation as a photon gas and Thermodynamic functions of photon gas. Bose derivation of Planck's law.

Fermi-Dirac Statistics: Fermi-Dirac Distribution Law, Thermodynamic functions of a Completely and strongly degenerate Fermi Gas, Fermi Energy Electron gas in a Metal, Specific Heat of Metals, Relativistic Fermi gas, White Dwarf Stars, Chandrasekhar Mass Limit**.**

Theory of Radiation: Properties of Thermal Radiation and Radiation Pressure. Blackbody Radiation and its spectral distribution. Kirchhoff law. Stefan-Boltzmann law and its Thermodynamic proof. Wien's Displacement law. Wien's Distribution Law. Rayleigh-Jean's Law. Planck's Quantum Postulates. Planck's Law of Blackbody Radiation Displacement law from Planck's law.

BOOKS FOR REFERENCES:

1. Statistical Mechanics: R.K. Pathria and P. D. Beale(Academic Press)
2. Introductory Statistical Mechanics: R. Bowley and M. Sanchez (Oxford Univ.Press)
3. Statistical Physics: F. Mandl (Wiley)
4. A treatise on Heat : M.N. Saha and B.N. Srivastava (Indian Press)
5. Problems and Solutions on Thermodynamics andStatistical Mechanics : Lim Yung-Kou

CO-PO & PSO Correlation

Course Name : Statistical Mechanics (SOS-B-PH602)													
	Program Outcomes								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:	2	2	1	2	2	1		2	2	1	2	1	2
CO2:		1	1	3	1		3	1	1	3		2	1
CO3:	2	1	2	1	2	1		1	2	2	1	1	
CO4:	2	3	1	1			1	3	1	2	2	1	2
CO5:	2	2	1	2	2	1		2	2	1		1	1
CO6:	3	1		3	2	2	3	3	1		3	2	2

Note: 1: Low 2.: Moderate 3: High

Statistical Mechanics Lab (SOS-B-PH602)

Course Description:

The course comprises the practical work related to Statistical Mechanics.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Gain practical knowledge for solving the problems based on Statistical Mechanics using C/C++/Scilab/Python/other numerical simulations.
CO2	Understand simulations methods to plot Planck's law of Black body radiation.
CO3	Study Maxwell-Boltzmann/ Fermi-Dirac/Bose Einstein statistics using numerical simulations.
CO4	Simulation methods to find partition function, probability of various macrostates, the plot of temperature dependent specific heat, etc.

Syllabus:

At least 06 experiments from the following

1. Use C/C++/Scilab/Python/other numerical simulations for solving the problems based on Statistical Mechanics like:
2. Plot the probability of various macrostates in coin-tossing experiment (two level system) versus number of heads with 4, 8, 16 coins etc.
3. Computation of the partition function Z(b) for the systems with a finite number of single particle levels (e.g., 2 level, 3 level etc.) and finite number of non-interacting particles N under Maxwell-Boltzmann/ Fermi-Dirac/Bose Einstein statistics:
   a) Study the behavior of Z(b), average energy, Cv, and entropy and its dependence upon the temperature, total number of particles N and the spectrum of single particle energy states.
   b) Plot the probability of occupancy of all the states w.r.t. temperature.
4. Plot the Maxwell speed distribution function at different temperatures in a 3-dimension system. Calculate the average speed, root mean square and most probable speed
5. Plot Specific Heat of Solids w.r.t temperature
   a) Dulong-Petit law,
   b) Einstein distribution function
   c) Debye distribution function
6. Plot the following functions with energy at different temperatures
   a) Maxwell-Boltzmann distribution
   b) Fermi-Dirac distribution
   c) Bose-Einstein distribution
7. Plot the distribution of particles w.r.t. energy (dN/de versus e) in 3 Dimensions for
   a) Relativistic and non-relativistic bosons both at high and low temperature.
   b) Relativistic and non-relativistic fermions both at high and low temperature.
8. Plot Planck's law of Black body radiation w.r.t. wavelength/frequency at different temperatures. Compare it with Rayleigh-Jeans Law and Wien's distribution law for a given temperature.

CO-PO & PSO Correlation

Course Name : Statistical Mechanics Lab (SOS-B-PH602)

	Program Outcomes								PSOs				
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1:	**3**	**3**	**2**	**3**	**2**	**3**	**2**	**1**	**3**	**2**	**2**	**2**	**3**
CO2:	**2**	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**2**
CO3:	**3**	**3**	**3**	**2**	**2**	**2**	**3**	**1**	**3**	**3**	**2**	**3**	**3**
CO4:	**2**	**2**	**2**	**2**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**

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Programme:	**B.Sc. (Hons) Physics**	**Semester :**	**V Sem**
Name of the Course:	**Nuclear and Particle Physics**	**Course Code:**	**SOS-B-PH503 (i)**
Credits :	**6**	**No of Hours :**	
Max Marks:	**100**		

Course Description:

The objective of the course is to impart the understanding of the sub atomic particles and their properties. It will emphasize to gain knowledge about the different nuclear techniques and their applications in different branches Physics and societal application. The course will focus on the developments of problem based skills.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Understand the basic properties of nuclei as well as knowledge of experimental determination of the same, the concept of binding energy, its various dependent parameters, N-Z curves and their significance.
CO2	Appreciate the formulations and contrasts between different nuclear models such as Liquid drop model, Fermi gas model and Shell Model and evidences in support.
CO3	Familiarize with different types of nuclear reactions, Q- values, compound and direct reactions.
CO4	Gain the Knowledge of radioactivity and decay laws. A detailed analysis, comparison and energy kinematics of alpha, beta and gamma decays.
CO5	Know about energy losses due to ionizing radiations, energy losses of electrons, gamma ray interactions through matter and neutron interaction with matter.
CO6	Acquaint with the nature and magnitude of different forces, particle interactions, families of sub- atomic particles with the different conservation laws, concept of quark model.

Syllabus:

General Properties of Nuclei: Constituents of nucleus and their Intrinsic properties, quantitative facts about mass, radii, charge density, matter density (experimental determination of each), binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve, N/Z plot, angular momentum, parity, magnetic moment, electric moments.

Nuclear Models: Liquid drop model approach, semi empirical mass formula and significance of its various terms, condition of nuclear stability, nucleon separation energies (up to two nucleons), Fermi gas model, basic assumptions of shell model.

Radioactivity decay: Alpha decay: basics of α-decay processes, theory of α-emission, Gamow factor, Geiger Nuttall law, α-decay spectroscopy, decay Chains.

β- decay: energy kinematics for β-decay, β-spectrum, positron emission, electron capture, neutrino hypothesis.

Gamma decay: Gamma rays emission from the excited state of the nucleus & kinematics, internal conversion.

Nuclear Reactions: Types of Reactions, units of related physical quantities, Conservation Laws, kinematics of reactions, Q-value, reaction rate, reaction cross section, Concept of compound and direct reaction, resonance reaction, Coulomb scattering (Rutherford scattering).

Particle physics: Particle interactions (concept of different types of forces), basic features, Cosmic Rays, types of particles and its families, Conservation Laws (energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin, Strangeness) concept of quark model, color quantum number and gluons.

BOOKS FOR REFERENCE:

1. Basic ideas and concepts in Nuclear Physics: An introductory approach by K Heyde, third edition, IOP Publication, 1999.
2. Nuclear Physics by S N Ghoshal, First edition, S. Chand Publication, 2010.
3. Introductory Nuclear Physics by K S Krane, Wiley-India Publication, 2008.
4. Nuclear Physics: principles and applications by J Lilley, Wiley Publication, 2006.
5. Radiation detection and measurement, G F Knoll, John Wiley & Sons, 2010.
6. Introduction to elementary particles by D J Griffiths, Wiley, 2008.

CO-PO & PSO Correlation

Course Name : Nuclear and Particle Physics (SOS-B-PH503 (i))													
	Program Outcomes								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:	2	2	1	2	2	1			2	1			1
CO2:	1	1	1	3	1	2	2	3	1	2	2	1	
CO3:		1	2	1	2	1	2	1		1	1	1	1
CO4:		3	1	1		1	1	1		2	3	1	
CO5:	2	2	1	2	2	1	2	3	1	2	1	2	1
CO6:	1	1		3	2	1			2	1			1

Note: 1: Low 2.: Moderate 3: High

Programme: **B.Sc. (Hons) Physics** **Semester :** **V Sem**

Name of the Course: **Physics of Devices and Communication** **Course Code:** **SOS-B-PH503 (ii)**

Credits : **6** **No of Hours :**

Max Marks: **100**

Course Description:

This paper is based on advanced electronics which covers the devices such as UJT, JFET, MOSFET, CMOS etc. Process of IC fabrication is discussed in detail. Digital Data serial and parallel Communication Standards are described along with the understanding of communication systems.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Develop the basic knowledge of semiconductor device physics and electronic circuits along with the practical technological considerations and applications.
CO2	Understand the operation of devices such as UJT, JFET, MOS,

	various bias circuits of MOSFET, Charge coupled Devices and Tunnel Diode.
CO3	Learn to analyze MOSFET circuits and develop an understanding of MOSFET I-V characteristics and the allowed frequency limits.

Syllabus:

Devices: Characteristic and small signal equivalent circuits of UJT and JFET. Metal-semiconductor Junction. Metal oxide semiconductor (MOS) device. Ideal MOS and Flat Band voltage. SiO2-Si based MOS, C-V characteristics of MOS, MOSFET– their frequency limits. Enhancement and Depletion Mode MOSFETS, CMOS. Charge coupled devices.

Processing of Devices: Basic process flow for IC fabrication. Crystal plane and orientation. Diffusion and implantation of dopants. Passivation. Oxidation Technique for Si. Contacts and metallization technique. Wet etching. Dry etching (RIE). Electron-lithography, Basic idea of SSI, MSI, LSI, VLSI and USI.

Introduction to communication systems: Block diagram of electronic communication system, Need for modulation. Amplitude modulation. Modulation Index. Analysis of Amplitude Modulated wave. Sideband frequencies in AM wave. CE Amplitude Modulator. Demodulation of AM wave using Diode Detector. Frequency modulation and demodulation, basic idea of Frequency, Phase, Pulse and Digital Modulation including ASK, PSK, FSK.

BOOKS FOR REFERENCE:

1. Physics of Semiconductor Devices, S.M.Sze and K.K.Ng, 3rd Edition 2008, John Wiley & Sons
2. Electronic Devices and Circuits, A. Mottershead, 1998, PHI Learning Pvt. Ltd.
3. Electronic Communication systems, G. Kennedy, 1999, Tata McGraw Hill.
4. Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
5. Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.

CO-PO & PSO Correlation

Course Name : Physics of Devices and Communication (SOS-B-PH503													
	Program Outcomes								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:	1	2	1	1		1	1	2	1	2	3	2	2
CO2:	1	3	1	1	2		1	2	2	1	3		1

CO3:	**2**	**1**	**2**	**3**	**2**	**1**	**1**		**2**	**2**	**2**	**1**	**2**

Note: 1: Low 2.: Moderate 3: High

Physics of Devices and Communication Lab (SOS-B-PH503)

Course Description:

The course comprises the session on the construction and use of CRO, and other experimental apparatuses used in the lab, including necessary precautions. Sessions on the review of experimental data analysis, sources of error and their estimation in detail, writing of scientific laboratory reports including proper reporting of errors. Application to the specific experiments done in the lab.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Gain practical knowledge to design a power supply, Low pass and High pass filters, Amplitude Modulator using Transistor.
CO2	Practically study characteristics of a JFET, MOSFET, and a UJT.
CO3	Practically study a PLL IC (Lock and capture range), envelope detector for demodulation of AM signal, ASK and FSK modulator.
CO4	Gain practical knowledge to design an Astable multivibrator.

Syllabus:

At least 06 experiments are to be performed.

1. To design a power supply using bridge rectifier and study effect of C-filter.
2. To design the active Low pass and High pass filters of given specification.
3. To design the active filter (wide band pass and band reject) of given specification.
4. To study the output and transfer characteristics of a JFET.
5. To design a common source JFET Amplifier and study its frequency response.
6. To study the output characteristics of a MOSFET.
7. To study the characteristics of a UJT and design a simple Relaxation Oscillator.
8. To design an Amplitude Modulator using Transistor.
9. To design PWM, PPM, PAM and Pulse code modulation using ICs.

10. 10.To design an Astable multivibrator of given specifications using transistor.
11. To study a PLL IC (Lock and capture range).
12. To study envelope detector for demodulation of AM signal.
13. Study of ASK and FSK modulator.

CO-PO & PSO Correlation

Course Name : Physics of Devices and Communication Lab (SOS-B-PH503)

	Program Outcomes								PSOs				
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1:	**2**	**3**	**2**	**3**	**3**	**3**	**2**	**1**	**3**	**1**	**2**	**2**	**2**
CO2:	**2**	**3**	**2**	**3**	**3**	**3**	**1**	**1**	**2**	**2**	**2**	**2**	**3**
CO3:	**3**	**2**	**3**	**2**	**2**	**2**	**3**	**1**	**2**	**3**	**2**	**3**	**2**
CO4:	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**2**	**2**	**2**	**2**	**2**	**3**

Note: 1: Low 2.: Moderate 3: High

Programme: **B.Sc. (Hons) Physics** **Semester :** **V Sem**
Name of the Course: **Experimental Techniques** **Course Code:** **SOS-B-PH504 (i))**
Credits : **6** **No of Hours :**
Max Marks: **100**

Course Description:
This paper aims to describe the errors in measurement and statistical analysis of data required while performing an experiment. Also, students will learn the working principle, efficiency and applications of transducers & industrial instrument like digital multimeter, RTD, Thermistor, Thermocouples and Semiconductor type temperature sensors.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Learn the measurement systems, errors in measurements and statistical treatment of data.

CO2	About Noise and signal, signal to noise ratio, different types of noises and their identification.
CO3	Concept of electromagnetic interference and necessity of grounding.
CO4	Understand principle of working and industrial applications of various transducers like Electrical, Thermal and Mechanical systems commonly used to measure Temperature and Position in industry.
CO5	Develop an understanding of construction and working of different measuring instruments.
CO6	Develop an understanding of construction, working and use of different AC and DC bridges and its applications.

Syllabus:

Measurements: Accuracy and precision. Significant figures. Error and uncertainty analysis. Types of errors: Gross error, systematic error, random error. Statistical analysis of data (Arithmetic mean, deviation from mean, average deviation, standard deviation, chi-square) and curve fitting. Gaussian distribution.

Signals and Systems: Fluctuations and Noise in measurement system. S/N ratio and Noise figure. Noise in frequency domain. Sources of Noise: Inherent fluctuations, Thermal noise, Shot noise, 1/f noise

Shielding and Grounding: Methods of safety grounding. Energy coupling. Grounding. Shielding: Electrostatic shielding. Electromagnetic Interference.

Transducers & industrial instrumentation (working principle, efficiency, applications): Static and dynamic characteristics of measurement Systems. Generalized perform ance of systems, Zero order first order, second order and higher order systems. Electrical, Thermal and Mechanical systems. Calibration. Qualitative difference between Transducers and sensors. Types of sensors (Physical, Chemical and Biological), Characteristics of Transducers. Transducers as electrical element and their signal conditioning.

Radiation Sensors: Principle of Gas filled detector, ionization chamber, scintillation detector.

Digital Multimeter: Comparison of analog and digital instruments. Block diagram of digital multimeter, principle of measurement of I, V, C. Accuracy and resolution of measurement. **Impedance Bridges and Q-meter:** Block diagram and working principles of RLC bridge. Q-meter and its working operation. Digital LCR bridge.

Vacuum Systems: Characteristics of vacuum: Gas law, Mean free path. Application of vacuum. Vacuum system- Chamber with roughing and backing, Mechanical pumps (Rotary and root pumps), Diffusion pump & Turbo Molecular pump, Ion pumps, Pumping speed, throughput, Pressure gauges (Pirani, Penning, ionization, cold cathode).

BOOKS FOR REFERENCE:

1. Experimental Methods for Engineers, J.P. Holman, McGraw Hill
2. Introduction to Measurements and Instrumentation, A.K. Ghosh, 4th Edition, 2017, PHI Learning Pvt. Ltd.
3. Transducers and Instrumentation, D.V.S. Murty, 2nd Edition, PHI Learning Pvt. Ltd.
4. Instrumentation Devices and Systems, C.S.Rangan, G.R. Sarma, V.S.V. Mani, Tata McGraw Hill
5. Measurement, Instrumentation and Experiment Design in Physics & Engineering, M.Sayer and A. Mansingh, 2005, PHI Learning.

CO-PO & PSO Correlation

Course Name : Experimental Techniques (SOS-B-PH504 (i))													
	Program Outcomes								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:	1	2	2	1		2			2	1	2	1	1
CO2:	1	3	1		3	1	2	3	1	2	2	1	
CO3:	2	1	2	1		1	2	1		1	1	1	1
CO4:	1	1			1	3	1	1		2	3	1	
CO5:	1	2	2	1		2	2	3	1	2	1	2	1
CO6:	1	2	2	1	3		1	1	2	1	3		1

Note: 1: Low 2.: Moderate 3: High

Experimental Techniques Lab (SOS-B-PH504 (i))

Course Description:

Sessions on the construction and use of specific measurement instruments and experimental apparatuses used in the physics lab, including necessary precautions. Sessions on the review of experimental data analysis, sources of error and their estimation in detail, writing of scientific laboratory reports including proper reporting of errors. Application to the specific experiments done in the lab.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Gain practical knowledge of experimental techniques such as Thermostat, ultrasonic transducer, Strain Gauge, LVDT.
CO2	Practically experience to reate vacuum in a small chamber.
CO3	Design and study the Sample and Hold Circuit.
CO4	Gain practical knowledge to compare pickup of noise in cables of different types.

Syllabus:

At least 06 experiments each from the following

1. Determine output characteristics of a LVDT & measure displacement using LVDT
2. Measurement of Strain using Strain Gauge, level using capacitive transducer, distance using ultrasonic transducer
3. To study the characteristics of a Thermostat and determine its parameters.
4. Calibrate Semiconductor type temperature sensor (AD590, LM35, LM75) and Resistance Temperature Device (RTD).
5. Create vacuum in a small chamber using a mechanical (rotary) pump and measure the chamber pressure using a pressure gauge.
6. Comparison of pickup of noise in cables of different types (co-axial, single shielded, double shielded, without shielding) of 2mlength, understanding of importance of grounding using function generator of mV level & an oscilloscope.
7. To design and study the Sample and Hold Circuit.
8. Design and analyze the Clippers and Clampers circuits using junction diode
9. To plot the frequency response of a microphone.
10. To measure Q of a coil and influence of frequency, using a Q-meter.

CO-PO & PSO Correlation

Course Name: Experimental Techniques Lab (SOS-B-PH504 (i))

	Program Outcomes								PSOs				
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1:	**2**	**3**	**2**	**2**	**3**	**2**	**2**	**1**	**3**	**1**	**2**	**2**	**3**
CO2:	**3**	**2**	**2**	**2**	**3**	**2**	**1**	**2**	**2**	**2**	**2**	**3**	**2**
CO3:	**3**	**2**	**3**	**3**	**2**	**2**	**3**	**1**	**2**	**3**	**2**	**2**	**2**
CO4:	**2**	**2**	**3**	**3**	**2**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**3**

Note: 1: Low 2.: Moderate 3: High

Programme: **B.Sc. (Hons) Physics** **Semester :** **V Sem**

Name of the Course: **Communication System** **Course Code:** **SOS-B-PH504 (ii)**

Credits : **6** **No of Hours :**

Max Marks: **100**

Course Description:

This paper aims to describe the concepts of electronics in communication and communication techniques based on Analog Modulation, Analog and digital Pulse Modulation. Communication and Navigation systems such as GPS and mobile telephony system are also introduced. This paper will essentially connect the text book knowledge with the most popular communication technology in real world.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Understand of fundamentals of electronic communication system and electromagnetic communication spectrum with an idea of frequency allocation for radio communication system in India.
CO2	Gain an insight on the use of different modulation and demodulation techniques used in analog communication

CO3	Learn the generation and detection of a signal through pulse and digital modulation techniques and multiplexing
CO4	Gain an in-depth understanding of different concepts used in a satellite communication system.
CO5	Study the concept of Mobile radio propagation, cellular system design and understand mobile technologies like GSM and CDMA.
CO6	Understand evolution of mobile communication generations 2G, 3G, and 4G with their characteristics and limitations.
CO7	Apply the theoretical concepts to gain hands on experience in building modulation and demodulation circuits; Transmitters and Receivers for AM and FM.

Syllabus:

Electronic communication: Introduction to communication – means and modes. Power measurements (units of power). Need for modulation. Block diagram of an electronic communication system. Brief idea of frequency allocation for radio communication system in India (TRAI). Electromagnetic communication spectrum, band designations and usage. Channels and base-band signals.

Analog Modulation: Amplitude Modulation, modulation index and frequency spectrum. Generation of AM (Emitter Modulation), Amplitude Demodulation (diode detector), Single Sideband (SSB) systems, advantages of SSB transmission, Concept of Single side band generation and detection. Frequency Modulation (FM) and Phase Modulation (PM), modulation index and frequency spectrum, equivalence between FM and PM, Generation of FM using VCO, FM detector (slope detector),Qualitative idea of Super heterodyne receiver.

Analog Pulse Modulation: Channel capacity, Sampling theorem, Basic Principles-PAM, PWM, PPM, modulation and detection technique for PAM only, Multiplexing (time division multiplexing and frequency division multiplexing).

Digital Pulse Modulation: Need for digital transmission, Pulse Code Modulation, Digital Carrier Modulation Techniques, Sampling, Quantization and Encoding. Concept of Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying(PSK), and Binary Phase Shift Keying (BPSK).

Satellite Communication: Introduction, need, Geosynchronous satellite orbits, geostationary satellite advantages of geostationary satellites. Transponders (C - Band),

Uplink and downlink, path loss, Satellite visibility, Ground and earth stations. Simplified block diagram of earth station.

Mobile Telephony System: Basic concept of mobile communication, frequency bands used in mobile communication, concept of cell sectoring and cell splitting, SIM number, IMEI number, need for data encryption, architecture (block diagram) of mobile communication network, idea of GSM, CDMA, TDMA and FDMA technologies, simplified block diagram of mobile phone handset, 2G, 3G and 4G concepts (qualitative only), GPS navigation system (qualitative idea only).

BOOKS FOR REFERENCE:

1. Electronic Communications, D. Roddy and J. Coolen, Pearson Education India.
2. Advanced Electronics Communication Systems- Tomasi, 6th Edn. Prentice Hall.
3. Electronic Communication systems, G. Kennedy, 3rd Edn., 1999, Tata McGraw Hill.
4. Principles of Electronic communication systems – Frenzel, 3rd edition, McGraw Hill

CO-PO & PSO Correlation

Course Name : Communication System (SOS-B-PH504 (ii))													
	Program Outcomes								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:	1	2	2	2	1	2	2	1		2	2	1	2
CO2:	1	3		1	1	3	1		3	1	1	3	
CO3:	2	1	2	1	2	1	2	1		1	2	2	1
CO4:	1	1	2	3	1	1			1	3	1	2	2
CO5:	1	2	2	2	1	2	2	1		2	2	1	
CO6:	1	2	3	1		3	2	2	3	3	1		3
CO7:	1	3	2	2	1	2	2	1		2	2	1	2

Note: 1: Low 2.: Moderate 3: High

Communication System Lab (SOS-B-PH504 (ii))

Course Description:
This course comprises practical knowledge of communication system.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Gain practical knowledge of communication system.
CO2	Practically experience to design AM, FM and pulse modulator using Transistor.
CO3	Study of AM, FM Transmitter and Receiver.
CO4	Gain practical knowledge of envelope detector for demodulation of AM signal.

Syllabus:

At Least 05 Experiments from the following

1. To design an Amplitude Modulator using Transistor
2. To study envelope detector for demodulation of AM signal
3. To study FM - Generator and Detector circuit
4. To study AM Transmitter and Receiver
5. To study FM Transmitter and Receiver
6. To study Time Division Multiplexing (TDM)
7. To study Pulse Amplitude Modulation (PAM)
8. To study Pulse Width Modulation (PWM)
9. To study Pulse Position Modulation (PPM)
10. To study ASK, PSK and FSK modulators

REFERENCES FOR LABORATORY WORK:

1. Electronic Communication system, Blake, Cengage, 5th edition.
2. Introduction to Communication systems, U. Madhow, 1st Edition, 2018, Cambridge University Press

CO-PO & PSO Correlation

Course Name: Communication System Lab (SOS-B-PH504 (ii))

	Program Outcomes								PSOs				
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**

CO1:	**3**	**2**	**2**	**2**	**3**	**2**	**2**	**2**	**3**	**1**	**2**	**2**	**2**
CO2:	**2**	**2**	**2**	**2**	**3**	**2**	**2**	**2**	**2**	**3**	**2**	**2**	**2**
CO3:	**3**	**2**	**2**	**3**	**2**	**2**	**2**	**1**	**1**	**3**	**2**	**2**	**1**
CO4:	**2**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**2**	**1**	**2**	**2**	**3**

Note: 1: Low 2.: Moderate 3: High

Programme: **B.Sc. (Hons) Physics** **Semester :** **VI Sem**

Name of the Course: **Nano Materials and Applications** **Course Code:** **SOS-B-PH603 (i)**

Credits : **6** **No of Hours :**

Max Marks: **100**

Course Description:

This course introduces briefly the basic concepts of Quantum Mechanics and principles required to understand nano-materials. Various nano-material synthesis/growth methods and characterizations techniques are discussed to explore the field in detail. The effect of dimensional confinement of charge carries on the electrical, optical and structural properties are discussed.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Understand the basic concepts of Quantum Mechanics and solve Schrodinger wave equation for simple problems.
CO2	Explain the difference between nano-materials and bulk materials and their properties.
CO3	Explain the role of confinement on the density of state function and so on the various properties exhibited by nano-materials compared to bulk materials.
CO4	Explain various methods for the synthesis/growth of nano-materials including top down and bottom up approaches.
CO5	Explain various applications of nano particles, quantum dots,

	nano wires etc.
CO6	Analyze the data obtained from the various characterization techniques.

Syllabus:

Brief Historical achievements: Use of nano-particle by artisans or craftsman's in glass wares, pottery etc. Introduction to naturally occurring nano-particles/nanostructures (explore the surroundings). Discussion on Michael Faraday's experiment with the gold films.

Basic Quantum Mechanics: Idea about particles as wave, electron interference experiment, superposition principle, position (or amplitude), and momentum. Wave-particle duality, uncertainty principle, energy quantization, Schrodinger equation. Applications of Schrodinger equation (**qualitative**): The free particle, potential step, rectangular potential barrier and the tunnel effect, free and bound states of a particle in square well potential, particle in a box (3D) problem.

Basic Introduction to solids and Nano-scale Systems: Classification of solids into crystalline and amorphous materials, classification based on conductivity (range of values) as metals, semiconductors and insulators, idea of band gap and its consequences on optical and electrical properties, electrons as free particles for current conduction (I = nevA), introduce bulk (3D) and nanomaterials {thin films (2D), nano wires (1D) nano dots or quantum dots (0D)} with an example of the colour of say Gold metals and its nano particles. Bulk materials Density of states function and its implication on electrical properties, Band structure and density of states function for nanoscale materials.

Synthesis and Characterization (Qualitative): Top down and Bottom up approach, Photolithography. Ball milling. Spin coating, Vacuum deposition: Physical vapor deposition (PVD): Thermal evaporation, Sputtering, Pulsed Laser Deposition (PLD), electric arc deposition for CNT, C60, grapheme, Chemical vapor deposition (CVD). Preparation through colloidal methods (Metals, Metal Oxide nanoparticles), MBE growth of quantum dots.

Structure and Surface morphology: X-Ray Diffraction (XRD). Scanning Electron Microscopy (SEM), Scanning Tunnel Microscopy (STM) (must discuss Quantum Corral). Transmission Electron Microscopy (TEM). **Spectroscopy:** UV-Vis spectroscopy. (Emphasis should be on to discuss data and plots gathered from these techniques)

Optical and Electron Transport Properties: Bandgap tuning as a function of particle size (discuss results of oxide and metal nanoparticles) Radiative processes: General formalization-absorption, emission and luminescence. Defects and impurities. Idea about time and length scale, diffusive and ballistic transport of electrons in nanostrcutures, Discuss interesting experiments (no derivations) (1) Charging effect, Coulomb blockade effect (2) Single electron device.

BOOKS FOR REFERENCE:

1. Introduction to Nanoelectronics, V.V. Mitin, V.A. Kochelap and M.A. Stroscio, 2011, Cambridge University Press.
2. C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology 1st edition (2003) Wiley India Pvt. Ltd.
3. S.K. Kulkarni, Nanotechnology: Principles & Practices 2nd edition (2011) (Capital Publishing Company)
4. K.K. Chattopadhyay and A. N. Banerjee, Introduction to Nanoscience and Technology (2009) (PHI Learning Private Limited).
5. Electronic transport in mesoscopic systems by SupriyoDatta (1997) Cambridge University Press.

CO-PO & PSO Correlation

Course Name : Nano Materials and Applications (SOS-B-PH603 (i))													
	Program Outcomes								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:	2	2	1	2	2	1		2	2	1	2	2	3
CO2:		1	1	3	1		3	1	1	2	3	1	
CO3:	2	1	2	1	2	1		1	1	2	1	2	2
CO4:	2	3	1	1			1	3	3	1	1	2	3
CO5:	2	2	1	2	2	1		2	2	2	3	1	1
CO6:	3	1		3	2	2	3	3	2	2	1	2	3

Note: 1: Low 2.: Moderate 3: High

Nano Materials and Applications Lab (SOS-B-PH603 (i))

Course Description:

This course comprises practical knowledge of nanomaterials and how they are utilized in various sectors.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Gain practical experiences of synthesizing metal nanoparticles.
CO2	Practical experience to synthesize semiconductor nanostructures.
CO3	Experimental study of optical properties of nanomaterials.
CO4	Gain practical knowledge to prepare nanomaterials thin films and study its structural and optical properties.

Syllabus:

At least 06 experiments from the following:

1. Synthesis of metal (Au/Ag) nanoparticles by chemical route and study/observe its optical absorption properties.
2. Synthesis of semiconductor (CdS/ZnO/TiO2/Fe2O3etc) nanoparticles and study/observe its optical absorption properties.
3. Study the XRD pattern of nanoparticles and estimation the particle size.
4. Surface Plasmon study of metal nanoparticles by UV-Visible spectrophotometer.
5. To study/observe the effect of size on color of nanomaterials.
6. To prepare composite of CNTs with other materials.
7. Growth of quantum dots by thermal evaporation.
8. Prepare a disc of ceramic of a compound and study its XRD.
9. Fabricate a thin film of nanoparticles by spin coating (or chemical route) and study its XRD and UV-Visible spectra.
10. Prepare a thin film capacitor and measure capacitance as a function of temperature or frequency.
11. Fabricate a PN diode by diffusing Al over the surface of N-type Si/Ge and study its V-I characteristic.

REFERENCE FOR PRACTICAL WORK:

1. C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology 1st edition (2003) Wiley India Pvt.Ltd.
2. S.K. Kulkarni, Nanotechnology: Principles & Practices 2nd edition (2011) (Capital Publishing Company).
3. K.K. Chattopadhyay and A. N. Banerjee, Introduction to Nanoscience and Technology (2009) (PHI Learning Private Limited).
4. Richard Booker, Earl Boysen, Nanotechnology for Dummies (2005) (Wiley Publishing Inc.).

CO-PO & PSO Correlation

Course Name: Nano Materials and Applications Lab (SOS-B-PH603 (i))													
	Program Outcomes								**PSOs**				
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1:	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**3**	**2**	**2**	**2**	**2**
CO2:	**2**	**2**	**2**	**2**	**3**	**2**	**2**	**2**	**2**	**3**	**2**	**3**	**3**
CO3:	**3**	**2**	**2**	**3**	**2**	**3**	**2**	**3**	**3**	**3**	**2**	**2**	**2**
CO4:	**2**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**2**	**1**	**2**	**2**	**3**

Note: 1: Low 2.: Moderate 3: High

Programme: **B.Sc. (Hons) Physics**
Name of the Course: **Atmospheric Physics**
Credits : **6**
Max Marks: **100**

Semester : **VI Sem**
Course Code: **SOS-B-PH603 (ii)**
No of Hours :

Course Description:
This paper aims to describe the characteristics of the Earth's atmospheric thermal structure and chemical composition. It enables to learn remote sensing techniques to explore atmospheric processes and helps to understand long term oscillations and fluid system dynamics which control climate change. Also, it delineates characteristics of pollutants and aerosols variability in the lower and middle atmosphere.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Learn and understand structure of temperature profiles and fine scale features in the troposphere using observations.
CO2	Understand Atmospheric waves: surface water waves, atmospheric gravity waves, accoustic waves etc.
CO3	Learn remote sensing techniques such as radar, lidar, and satellite to explore atmospheric processes.
CO4	Understand properties of aerosols, their radiative and health effects.
CO5	Know the application of Lidar to study atmospheric phenomenon.
CO6	Learn Data analysis tools and techniques.

Syllabus:

General features of Earth's atmosphere: Thermal structure of the Earth's Atmosphere, Composition of atmosphere, Hydrostatic equation, Potential temperature, Atmospheric Thermodynamics, Greenhouse effect, Local winds, monsoons, fogs, clouds, precipitation, Atmospheric boundary layer, Sea breeze and land breeze. Instruments for meteorological observations including RS/RW, meteorological processes and convective systems, fronts, Cyclones and anticyclones, thunderstorms.

Atmospheric Dynamics: Scale analysis, Fundamental forces, Basic conservation laws, The Vectorial form of the momentum equation in rotating coordinate system, scale analysis of equation of motion, Applications of the basic equations, Circulations and vorticity, Atmospheric oscillations, Quasi biennial oscillation, annual and semi-annual oscillations, Mesoscale circulations, The general circulations, Tropical dynamics.

Atmospheric Waves: Surface water waves, wave dispersion, acoustic waves, buoyancy waves, propagation of atmospheric gravity waves (AGWs) in a nonhomogeneous medium, Lamb wave, Rossby waves and its propagation in three dimensions and in sheared flow, wave absorption, non-linear consideration.

Atmospheric Radar and Lidar: Radar equation and return signal, Signal processing and detection, Various type of atmospheric radars, Applications of radars to study

atmospheric phenomena, Lidar and its applications, Application of Lidar to study atmospheric phenomenon. Data analysis tools and techniques.

Atmospheric Aerosols: Spectral distribution of the solar radiation, Classification and properties of aerosols, Production and removal mechanisms, Concentrations and size distribution, Radiative and health effects, Observational techniques for aerosols, Absorption and scattering of solar radiation, Rayleigh scattering and Mie scattering, Bouguert-Lambert law, Principles of radiometry, Optical phenomena in atmosphere, Aerosol studies using Lidars.

BOOKS FOR REFERENCE:

1. Fundamental of Atmospheric Physics, M.L Salby; Academic Press, Vol 61, 1996
2. The Physics of Atmosphere – John T. Houghton; Cambridge University press; 3 rd edn. 2002.
3. An Introduction to dynamic meteorology – James R Holton; Academic Press, 2004
4. Radar for meteorological and atmospheric observations – S Fukao and K Hamazu, Springer Japan, 2014

CO-PO & PSO Correlation

Course Name : Atmospheric Physics (SOS-B-PH603 (ii))													
	Program Outcomes								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:	1	2	1	1	2	2	2	1	2	2	1	1	2
CO2:		1	2	3	1		1	1	3	1	2	3	1
CO3:	2		2	1		2	1	2	1	2	1		2
CO4:	1	3	1	1		2			1		3	1	2
CO5:	2	1	2		1	2	2	1	2	2	1		2
CO6:	1	2	1	1	2	3	1		3	2	2	3	3

Note: 1: Low 2.: Moderate 3: High

Atmospheric Physics Lab (SOS-B-PH603 (ii))

Course Description:
This course comprises practical knowledge of Atmospheric Physics.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Gain experiences of Numerical Simulation for atmospheric waves.
CO2	Practical experience of offline and online processing of radar data.
CO3	Experience of handling of satellite data and plotting of atmospheric parameters.
CO4	Gain practical knowledge of time series analysis of temperature using long term data over metropolitan cities in India.

Syllabus:

Scilab/C ++ based simulations experiments based on Atmospheric Physics problems like

At least 05 Experiments from the following

1. Numerical Simulation for atmospheric waves using dispersion relations
   i. Atmospheric gravity waves (AGW)
   ii. Kelvin waves
   iii. Rossby waves, and mountain waves
2. Offline and online processing of radar data
   i. VHF radar,
   ii. X-band radar, and
   iii. UHF radar
3. Offline and online processing of LIDAR data
4. Radiosonde data and its interpretation in terms of atmospheric parameters using vertical profiles in different regions of the globe.
5. Handling of satellite data and plotting of atmospheric parameters using radio occultation technique
6. Time series analysis of temperature using long term data over metropolitan cities in India – an approach to understand the climate change
7. PM 2.5 measurement using compact instruments.

REFERENCES FOR LABORATORY WORK:

Data sources for radar, lidar, satellite and radiosondes

1. https://www.narl.gov.in
2. http://www.imd.gov.in
3. https://www.ncmrwf.gov.in/
   https://www.aries.res.in/

CO-PO & PSO Correlation

Course Name: Atmospheric Physics Lab (SOS-B-PH603 (ii))													
	Program Outcomes								**PSOs**				
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1:	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**1**	**3**	**2**	**1**	**2**	**2**
CO2:	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**1**	**2**	**2**	**2**	**2**	**2**
CO3:	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**
CO4:	**2**	**2**	**2**	**2**	**2**	**3**	**2**	**2**	**2**	**1**	**2**	**2**	**2**

Note: 1: Low 2.: Moderate 3: High

Programme: **B.Sc. (Hons) Physics**
Name of the Course: **Energy Materials**
Credits : **6**
Max Marks: **100**

Semester : **VI Sem**
Course Code: **SOS-B-PH603 (iii)**
No of Hours :

Course Description:
This course aims to provide students an introduction to different energy-related technologies with emphasis on materials used in production and storage of energy. These materials include supercapacitor and battery materials, photovoltaic materials, the materials for fuel cell and hydrogen technology, and other energy harvesting materials, such as thermoelectric, piezoelectric, pyroelectric materials, etc .

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Understand the energy-related technologies including photovoltaics, hydrogen energy, super-capacitor and battery, fuel cell, thermos-electrics, piezo-electrics, and pyroelectrics
CO2	Learn how to select materials for energy devices and various different materials currently used in these devices
CO3	Understand the basics of Solar cell, solar cell parameters, losses and efficiency limits.
CO4	Learn about Materials for non-rechargeable batteries: alkaline battery, Materials for rechargeable batteries; aluminium-ion battery, lithium-ion battery.
CO5	Understand the Fuel cell fundamentals.
CO6	Know about Hydrogen production and storage in materials.

Syllabus:

Photovoltaic Materials: Optics of flat interfaces and light absorption, Solar radiation and solar spectra, solar energy concentration, Basics of Solar cell, solar cell parameters, losses and efficiency limits, Crystalline silicon solar cells, thin-film solar cells, and peroskite solar cells. PV modules and systems: components, design, and fabrication, PV system: economics and ecology.

Supercapacitor and Battery Materials: Electrochemical basics, electrochemical cell, charging and discharging, energy efficiency, cycle life Materials for electrode, electrolyte materials, Types and different device design of supercapacitors and their applications, Materials for non-rechargeable batteries: alkaline battery, Materials for rechargeable batteries; aluminium-ion battery, lithium-ion battery.

Fuel Cell: Fuel cell fundamentals, fuel cell types, charge transfer and mass transport in fuel cells, Thermodynamics and reaction kinetics in Fuel cell, Proton exchange membrane and solid oxide fuel cell materials, Fuel cell system design and characterization.

Hydrogen Technology: Hydrogen production: electrolytic production, thermal decomposition of water, chemical extraction, hydrogen from the decomposition of materials containing hydride anions, Hydrogen storage in materials: metal hydrides, ammonia and related materials, reversible organic liquids and nanomaterials (carbon nanotubes and graphene).

Energy Harvesting Materials: Thermoelectric, Piezoelectric, and Pyroelectric materials, Electrostatic (capacitive) Energy Harvesting and materials, energy from Magnetic Induction, Metamaterial, energy from atmospheric pressure changes, electroactive polymers (EAPs), nanogenerators, Ambient radiation sources and nanoantenna, energy from noise.

BOOKS FOR REFERENCE:

1. Energy Materials, D. W. Bruce, D. O'Hare, R. I. Walton, Wiley, 2011.
2. Solar Energy: The Physics and Engineering of Photovoltaic Conversion, Technologies and Systems, A. Smets, K. Jäger, O. Isabella, R. V. Swaaij, M. Zeman, UIT Cambridge, 2016.
3. Fuel Cell Fundamentals, O'Hayre, Cha, Colella, and Prinz, Wiley, any Edition
4. Energy Storage: Fundamentals, Materials and Applications, Robert Huggins, Springer, 2nd ed., 2016.
5. Thermoelectrics: Basic Principles and New Materials Developments", G.S. Nolas, J. Sharp, J. Goldsmid, Springer, 2001.
6. Thermoelectricity: An Introduction to the Principles", D. K. C. MacDonald, Dover Publications, 2006.

CO-PO & PSO Correlation

Course Name : Energy Materials (SOS-B-PH603 (iii))													
	Program Outcomes								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:	2	2	1	2	2	3	2	1	1	2	1	2	2
CO2:	1	1	2	2		1	1		3	1	1	2	3
CO3:	1	1		1	2	2	1	1	2	2	3	1	1
CO4:	1		1	1	2		1		2	2	1	2	3
CO5:	2	2	2	3	1	1	2		1	2	1	2	2
CO6:	1	2		1	2		2	1	3	1	1	2	3

Note: 1: Low 2.: Moderate 3: High

Programme: **B.Sc. (Hons) Physics** **Semester :** **VI Sem**

Name of the Course: **Physics of Earth** **Course Code:** **SOS-B-PH604 (i)**

Credits : **6** **No of Hours :**

Max Marks: **100**

Course Description:

This course familiarizes the students with the origin of universe and role of earth in the solar system.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Understand the structure of the earth as well as various dynamical processes occurring on it.
CO2	Apply physical principles of elasticity and elastic wave propagation to understand modern global seismology as a probe of the Earth's internal structure.
CO3	Understand the origin of magnetic field, Geodynamics of earthquakes and the description of seismic sources; a simple but fundamental theory of thermal convection; the distinctive rheological behaviour of the upper mantle and its top
CO4	Explore various roles played by water cycle, carbon cycle, nitrogen cycles in maintaining steady state of earth leading to better understanding of the contemporary dilemmas (climate change, bio diversity loss, population growth, etc.) disturbing the Earth.
CO5	Learn the various aspects of health of Earth.

Syllabus:

The Earth and the Universe:

Origin of universe, creation of elements and earth. A Holistic understanding of our dynamic planet through Astronomy, Geology, Meteorology and Oceanography . Introduction to various branches of Earth Sciences.

General characteristics and origin of the Universe. The Big Bang Theory. Age of the universe and Hubble constant. Formation of Galaxies. The Milky Way galaxy, Nebular Theory, solar system, Earth's orbit and spin, the Moon's orbit and spin. The terrestrial and Jovian planets. Titius-Bode law. Asteroid belt. Asteroids: origin types and examples. Meteorites & Asteroids. Earth in the Solar system ,origin, size, shape, mass, density, rotational and revolution parameters and its age.

Energy and particle fluxes incident on the Earth. (d) The Cosmic Microwave Background.

Structure:

The Solid Earth: Mass, dimensions, shape and topography, internal structure, magnetic field, geothermal energy. How do we learn about Earth's interior?

The Hydrosphere: The oceans, their extent, depth, volume, chemical composition. River systems.

The Atmosphere: layers, variation of temperature with altitude, adiabatic lapse rate, variation of density and pressure with altitude, cloud formation.

The Cryosphere: Polar caps and ice sheets. Mountain glaciers, permafrost.

Introduction to geophysical methods: Introduction to geophysical methods of earth investigations. Concept of plate tectonics; types of plate movements, hotspots; sea-floor spreading and continental drift.

Geodynamic elements of Earth: Mid Oceanic Ridges, trenches, transform faults and island arcs. Origin of oceans, continents, mountains and rift valleys. Earthquake and earthquake belts. Seismic waves, Richter scale, geophones. Volcanoes: types products and distribution.

Ocean circulations. Oceanic current system and effect of coriolis forces. Concepts of eustasy, tend – air-sea interaction; wave erosion and beach processes. Tides. Tsunamis.

Atmospheric circulation. Weather and climatic changes. Earth's heat budget. Cyclones and anti-cyclones. Biosphere: Water cycle, Carbon cycle. The role of cycles in maintaining a steady state.

Stratigraphy: Introduction and types, Standard stratigraphic time scale and introduction to the concept of time in geological studies. Time line of major geological and biological events. Introduction to geochronological methods and their application in geological studies. Radiometric dating: Advantages & disadvantages of various isotopes. Various laws of stratigraphy. Introduction to the geology and geomorphology of Indian subcontinent.

Disturbing the Earth – Contemporary dilemmas (a) Human population growth. (b) Atmosphere: Green house gas emissions, climate change, air pollution. (c) Hydrosphere: Fresh water depletion. (d) Geosphere: Chemical effluents, nuclear waste. (e) Biosphere: Biodiversity loss. Deforestation. Robustness and fragility of ecosystems.

BOOKS FOR REFERENCE:

1. Planetary Surface Processes, H. Jay Melosh, 2011, Cambridge University Press.
2. Holme's Principles of Physical Geology, 1992, Chapman & Hall.
3. Planet Earth, Cosmology, Geology and the Evolution of Life and Environment, C. Emiliani, 1992, Cambridge University Press.
4. Physics of the Earth, Frank D. Stacey, Paul M. Davis, 2008, Cambridge University Press.

CO-PO & PSO Correlation

Course Name : Physics of Earth (SOS-B-PH604 (i))													
	Program Outcomes								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:	1	2	2	1		2	2	1	1	2	2	2	2
CO2:	1	3	1		3	1	1	3	1	3	1	2	
CO3:	2	1	2	1		1	2	2	2	1	2	1	2
CO4:	1	1			1	3	1	2	1	1		1	2
CO5:	1	2	2	1		2	2	1	1	2	2	3	1

Note: 1: Low 2.: Moderate 3: High

Programme: **B.Sc. (Hons) Physics** **Semester :** **VI Sem**

Name of the Course: **Astronomy and Astrophysics** **Course Code:** **SOS-B-PH604 (ii))**

Credits : **6** **No of Hours :**

Max Marks: **100**

Course Description:

This course is designed to provide students with the basic knowledge about the theory and techniques of observational astronomy and physics of the astrophysical phenomenon. It applies theoretical concepts and mathematical techniques students have learnt in their earlier courses to astronomical and astrophysical phenomenon.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Learn the different types of telescopes, diurnal and yearly motion of astronomical objects, and astronomical coordinate systems and their transformations.
CO2	Learn about Brightness scale for stars, types of stars, their structure and evolution on HR diagram.
CO3	Understand the large scale structure of the Universe and its history.
CO4	Understand the Distribution of chemical compounds in the interstellar medium and astrophysical conditions necessary for the emergence and existence of life.
CO5	Learn about Sun's Internal Structure, Solar Photosphere, Solar Atmosphere, Chromosphere etc.
CO6	Understand thebasic Structure and Properties of the Milky Way.

Syllabus:

Introduction to Astronomy and Astronomical Scales: Overview of the Night Sky, Diurnal and Yearly motions of the Sun, Stars and Constellations. Size, Mass, Density and Temperature of Astronomical Objects. Basic concepts of Positional Astronomy: Celestial Sphere, Geometry of a Sphere, Spherical Triangle, Astronomical Coordinate Systems, Horizon System, Equatorial System, Conversion of Coordinates. Rising and Setting Times, Measurement of Time, Side real Time, Apparent Solar Time, Mean Solar Time, Equation of Time, Astronomical Time Systems (LMT, UT, UTC).

Basic Parameters of Stars: Determination of Distance by Parallax Method; Proper Motion, Brightness, Radiant Flux and Luminosity, Apparent andAbsolute Magnitude Scales, Distance Modulus, Extinction, Determination of Temperature and Radius of a star; Stellar Spectra,Atomic Spectra Revisited, Introduction to Boltzman and Saha Equations, Balmer Lines of H, H and K lines of Ca, Spectral Types and Their

Temperature Dependence, Black Body Approximation, Luminosity Classification, H R Diagram and Relations Between Stellar Parameters.

Observational Tools and Physical Principles: Observing through the atmosphere (Scintillation, Seeing , Atmospheric Windows and Extinction) Basic Optical Definitions for Telescopes: Magnification, Light Gathering Power, Limiting magnitude, Resolving Power, Diffraction Limit. Optical and Radio Telescopes, Current Indian Observatories. Virial theorem for N particle systems, applications in astrophysics. Systems in Thermodynamic Equilibrium, Equations for Hydrostatic equilibrium, Mean Molecular Weight of stellar gas, Stellar Energy Sources.

Sun and the Milky Way: Solar Parameters, Sun's Internal Structure, Solar Photosphere, Solar Atmosphere, Chromosphere. Corona, Solar Activity, Solar Magneto-Hydrodynamics, Alfven's Theorem. Basic Structure and Properties of the Milky Way, Nature of rotation of the Milky Way (Differential rotation of the Galaxy and Oort Constants, Rotation Curve of the Galaxy and the Dark Matter, Nature of the Spiral Arms), Properties of and Around the Galactic Nucleus.

Cosmology: Standard Candles (Cepheids and SNe Type1a), Cosmic Distance Ladder, Olbers Paradox, Hubble Expansion, Cosmological Principle, Newtonian Cosmology and Friedmann Models.

BOOKS FOR REFERENCE:

1. Fundamental of Astronomy (Fourth Edition), H. Karttunen et al. Springer
2. Astrophysics Stars and Galaxies K D Abhyankar, Universities Press
3. Modern Astrophysics, B.W. Carroll & D.A. Ostlie, Addison-Wesley Publishing Co.
4. BaidyanathBasu, An introduction to Astrophysics, Second printing, Prentice - Hall of India Private limited, New Delhi,2001.
5. Introductory Astronomy and Astrophysics, M. Zeilik and S.A. Gregory, 4th Edition, Saunders College Publishing.