M.Sc. Physics

Syllabus

PGP1501CM CLASSICAL MECHANICS AND NONLINEAR DYNAMICS

(THEORY)

COURSE OUTCOMES: **6 hrs./wk.**

On successful completion of the course, the student will be able to

CO1: interpret the generalised coordinates and employ the Lagrangian formulation for physical systems

CO2: describe the central force problem and relate the concept of small oscillations to molecular spectra

CO3: discuss the dynamics of rigid body using Euler's equations of motion

CO4: apply Lagrangian and Hamiltonian formulations in classical mechanics

CO5: distinguish linear and nonlinear systems and appreciate the concept of nonlinearity in chaotic systems

COURSE CONTENT:

UNIT I: FUNDAMENTAL PRINCIPLES AND LAGRANGIAN FORMULATION **18 hrs.**

Mechanics of a particle and system of particles – constrains – generalized coordinates – D'Alembert's principle and Lagrange's equations – applications of Lagrangian formulation – Hamilton's principle and Lagrange's equations for conservative holonomic and non-holonomic systems – conservation theorems and symmetry properties.

UNIT II: CENTRAL FORCE MOTION AND SMALL OSCILLATIONS **18 hrs.**

Central force problem – reduction to an equivalent one – body problem – virial theorem – Kepler problem – inverse square law of force – scattering in a central force field and laboratory coordinates system – small oscillations – formulation of problem – frequencies of free vibration and normal coordinates – free vibrations of a linear triatomic molecule – examples of two coupled oscillators – two coupled pendulum – double pendulum.

UNIT III: RIGID BODY DYNAMICS **18 hrs.**

Independent coordinates of a rigid body – Euler angles – motion of rigid body in time – Coriolis forces –angular momentum and kinetic energy of motion about a point – inertia tensor and moment of inertia – eigenvalues of inertia tensor and principal axis transformation – solving rigid body problems and Euler equations of motion – applications – torque free motion of a rigid body – heavy symmetrical top with one point fixed.

UNIT IV: HAMILTON'S FORMULATION **18 hrs.**

Legendre transformations and Hamilton equations of motion – cyclic coordinates and conservation theorems – derivation of Hamilton's equations from variational principle – principle of least action – canonical transformations – equations of canonical transformation – examples of canonical transformation – harmonic oscillator – Poisson brackets – Hamilton – Jacobi equation for Hamilton's principal function – Harmonic oscillator problem as an example of Hamilton – Jacobi method – action angle variables for completely separable systems – Kepler problem in action – angle variables.

UNITV: NON-LINEAR DYNAMICS **18 hrs.**

Dynamical systems – linear and nonlinear forces – mathematical implications of nonlinearity – working definitions and effects of nonlinearity – damped and driven nonlinear oscillators – autonomous and non-autonomous systems – dynamical systems as coupled first – order differential equations: equilibrium points – phase space/phase plane and phase trajectories – stability – attractors and repellers – classification of equilibrium – points – limit cycle motion – periodic attractor – simple bifurcations.

TEXT BOOK(S):

Goldstein H, Poole C & Safko J., (2007). *Classical Mechanics,* (3rd ed.), New Delhi: Pearson Education Pvt. ltd. Print.

Chapters. 1.1–1.4, 1.6, 2.1, 2.3, 2.4, 2.6, 3.1, 3.4,3.7, 3.10, 3.11, 6.1,6.3, 6.4, 4.1, 4.4, 4.10, 5.1,5.3 – 5.7, 8.1, 8.2, 8.5, 8.6, 9.1 – 9.3, 9.5,10.1, 10.2, 10.7, 10.8

Lakshmanan M & Rajasekar S., (2003). *Nonlinear Dynamics: Integrability, Chaos & Pattern,* New Delhi: Springer (India) Pvt. ltd. Print.

Chapters 1, 2.1, 2.2 , 3.1 – 3.5 , 4.1

Upadhyaya J.C., (2011). *Classical Mechanics*, Mumbai: Himalaya Publishing house. Print.

Chapters. 9.5

REFERENCE BOOK(S):

Feynman R. P. et al., (2008*). The Feynman Lectures on Physics* (Vol.1). New Delhi: Narosa Book Distributors. Print.

Rana N. C. & Joag P S., (2003). *Classical Mechanics*, New Delhi: Tata McGraw Hill. Print.

Robert C. Hilborn. (2004). *Chaos and Nonlinear Dynamics*. (2nd ed.), India: Oxford University press. Print.

Takwale R.S. & Puranik P.S., (2005). *Introduction to Classical Mechanics*. New Delhi: Tata McGraw Hill. Print.

WEBSITE(S):

http://www.picgames.com/forum/web/Science/Physics/classical_Mechanics/

http://dirs.org/dir – wiki.cfm/Top/Science/Physics/Classical_Mechanics

http://dirs.org/wiki – article – tab.cfm/classical_mechanics_1

http://physics.about.com/od/mechanics/

PGP1501CM CLASSICAL MECHANICS AND NONLINEAR DYNAMICS			
Class	I M.Sc. Physics	**Semester**	I
Cognitive Level	K-2 Understand		
	K-3 Apply		
	K-4 Analyze		
	K-6 Create		

MAPPING: COs consistency with PSOs

PGP1501CM CLASSICAL MECHANICS AND NONLINEAR DYNAMICS					
CO/PSO	**PSO**				
	1	**2**	**3**	**4**	**5**
CO1	3	1	1	1	1
CO2	3	3	3	1	2
CO3	3	3	2	1	1
CO4	3	2	3	1	1
CO5	3	3	1	1	1

Strongly correlated (3), Moderately correlated (2), Weakly correlated (1)

PGP1601CM MATHEMATICAL PHYSICS I

(THEORY)

COURSE OUTCOMES: **6 hrs./wk.**

On successful completion of the course, the student will be able to

CO1: explain fundamental concepts of vector calculus and tensor analysis

CO2: interpret linear vector spaces and solve homogeneous and nonhomogeneous systems using matrix representations

CO3: make use of special functions to solve real time problems

CO4: apply the tools of complex analysis to solve problems in advanced physics

CO5: analyze and use probability distributions for mathematical modeling

COURSE CONTENT:

UNIT I: VECTORS AND TENSORS ANALYSIS **18 hrs.**

Surfaces – scalar and vector fields – vector operators – vector operator formulae – cylindrical and spherical polar coordinates – general curvilinear coordinates – Green's theorem in a plane – integral forms for grad div and curl – divergence theorem – Stokes's theorem – tensors – notations – change of basis – Cartesian tensors – first and zero order Cartesian tensors – second and higher order Cartesian tensors – algebra of tensors – quotient law – Levi-Civita symbol – metric tensor – general coordinate transformations and tensors – derivatives of basis vectors and Christoffel symbols.

UNIT II: LINEAR VECTOR SPACES AND MATRIX ANALYSIS **18 hrs.**

Linear independence – rank of a matrix – vector spaces – matrix eigenvalue problems (Cayley Hamilton) – eigenvalues – eigenvectors – applications of eigenvalue problems – symmetric – skew-symmetric and orthogonal matrices – eigen bases – diagonalization – quadratic forms – complex matrices and forms.

UNIT III: SPECIAL FUNCTIONS **18 hrs.**

Legendre functions – Legendre functions for integer – properties of Legendre polynomials – Rodrigues formula – mutual orthogonality – associated Legendre functions – associated Legendre functions for integer – properties of associated Legendre functions – spherical harmonics – Bessel functions – Bessel functions for non-integer – Bessel functions for integer – properties of Bessel functions – Laguerre functions and Hermite functions (qualitative only).

UNIT IV: COMPLEX ANALYSIS **18 hrs.**

Derivative – analytic function – Cauchy-Riemann equations – Laplace's equation – Cauchy's integral theorem – Cauchy's integral formula – derivatives of analytic functions – Taylor and Maclaurin series – Laurent series – singularities zeros and infinity – Cauchy's residue integration method – Cauchy's residue theorem – residue integration of real integrals.

UNIT V: PROBABILITY AND STATISTICS **18 hrs.**

Data analysis – experiments outcomes and events – probability – permutations and combinations – random variables, probability distributions – mean and variance of a distribution – binomial – Poisson and normal distributions – random sampling – confidence intervals – goodness of fit – chi-square test – fitting straight lines.

TEXT BOOK(S):

Kreyszig, E., (2013). *Advanced Engineering Mathematics*, (9th ed.), New Delhi: Wiley India Pvt. Ltd. Print.

Chapters: 7.4, 8.1-8.5, 13.3, 13.4, 14.2 – 14.4, 15.4, 16.1-16.4, 24.2-24.8, 25.1, 25.3, 25.7, 25.9.

Riley, K.F., Hobson, M.P. & Bence, S.J., (2010). *Mathematical Methods for Physics and Engineering*, (3rd ed.), Cambridge University Press. Print.

Chapters: 10.5-10.10, 11.3, 11.7-11.9, 18.1-18.3, 18.5, 18.7, 18.9, 26.1-26.8, 26.15, 26.16, 26.18.

REFERENCE BOOK(S):

Mary L. Boas, (2015). *Mathematical methods in the Physical Sciences*, (2nd ed.), New York: John Wiley & Sons. Print.

Mathews & Walker, J., (2004). *Methods of Mathematical Physics*, New York: W.A. Benjamin Inc. Print.

Pipes, L.A. & Harvill, L. R., (2014). *Applied Mathematics for Engineers and Physicists*, (3rd ed.), Singapore: McGraw Hill Book Company. Print.

Weber & Arfken, (2004). *Essential Mathematical Methods for Physicists*, United States: Academic Press. Print.

PGP1601CM MATHEMATICAL PHYSICS I			
Class	I M.Sc. Physics	**Semester**	I

Cognitive Level	K-2 Understand
	K-3 Apply
	K-4 Analyse

MAPPING: COs consistency with PSOs

PGP1601CM MATHEMATICAL PHYSICS I					
CO/PSO	**PSO**				
	1	**2**	**3**	**4**	**5**
CO1	3	2	3	1	3
CO2	3	3	3	1	3
CO3	3	2	2	1	3
CO4	3	3	3	1	3
CO5	3	3	3	3	3

Strongly correlated (3), Moderately correlated (2), Weakly correlated (1)

PGP1502CM INTEGRATED ELECTRONICS

(THEORY)

COURSE OUTCOMES: **6 hrs./wk.**

On successful completion of the course, the student will be able to

CO1: analyze AC and DC characteristics of operational amplifier

CO2: design filters, oscillators and wave generators

CO3: relate digital concepts for designing counters, A/D and D/A converters

CO4: use modulation and demodulation techniques in designing communication systems

CO5: apply the principle used in transducers for various measurement methods

COURSE CONTENT:

UNIT I: OP-AMP – LINEAR APPLICATIONS **18 hrs.**

DC and AC amplifiers – AC amplifiers with a single supply voltage – peaking amplifier – summing scaling and averaging amplifiers – instrumentation amplifiers – differential input and differential output amplifier – voltage-to-current converter with floating load – voltage-to-current converter with grounded load – current-to-voltage converter – very high input impedance circuit – integrator – differentiator.

UNIT II: OP-AMPS – FILTERS & OSCILLATORS **18 hrs.**

Active filters – first-order low-pass butter worth filter – first-order high-pass butter worth filter – oscillators – phase shift oscillator – Wien bridge oscillator – square wave generator – triangular wave generator – basic comparator – zero- crossing detector – Schmitt Trigger – analog-to-digital and digital-to-analog converters – clippers and clampers.

UNIT III: DIGITAL ELECTRONICS **18 hrs.**

Combinational digital systems – standard gate assemblies – binary address – arithmetic functions – decoder / demultiplexer – data selector/ multiplexer – encoder – Read-only-memory(ROM) – ROM applications – sequential digital systems: a 1-bit memory – flip-flops – shift registers – ripple (asynchronous) counters – synchronous counters – D/A and A/D systems – digital-to-analog converters – analog-to-digital converter.

UNIT IV: MODULATION TECHNIQUES **18 hrs.**

Amplitude modulation – amplitude modulation index – modulation index for sinusoidal AM frequency spectrum for sinusoidal AM –

average power for sinusoidal AM – effective voltage and current for sinusoidal AM – non sinusoidal modulation – double sideband suppressed carrier (DSABSC) modulation – amplitude modulator circuits – amplitude demodulator circuits – angle modulation – frequency modulation – sinusoidal FM – frequency spectrum for sinusoidal FM – average power in sinusoidal FM – non-sinusoidal modulation – deviation ratio – measurement of modulation index for sinusoidal FM – phase modulation – equivalence between PM and FM.

UNIT V: TRANSDUCERS **18 hrs.**

Electrical transducer – selecting a transducer – resistive transducer – resistive position transducer – strain gauges – resistance thermometer – thermistor – inductive transducer – differential output transducer – linear variable differential transducer (LVDT) – capacitive transducer – load cells – piezo electrical transducer – photo electric transducer – photo voltaic cell – semiconductor photo diode – photo transistor.

TEXT BOOK(S):

Dennis Roddy & John Coolen, (2008). *Electronic Communications*, (4th ed.), New Delhi: Pearson Education. Print.

Chapters: 8.1-8.11, 10.1-10.9.

Jacob Millman & Christos C. Halkias, (2006). *Integrated Electronics: Analog and Digital Circuits and Systems*, New Delhi: Tata McGraw-Hill Publishing Company Limited. Print.

Chapters: 17.1-17.13, 17.19, 17.20.

Kalsi H.S (2009) *Electronic Instrumentation*. (2nd ed.), New Delhi: Tata McGraw-Hill Publishing Company Limited. Print, Chapters: 13.1-13.11, 13.13-13.19.

Ramakant A. Gayakwad, (2001) *Op-amps and linear integrated circuits*. (4th ed.). New Delhi: Prentice Hall of India. Print.

Chapters: 6.1-6.13, 7.1-7.3, 7.5, 7.11-7.13, 7.15, 7.16, 8.1-8.4, 8.11, 8.12.

REFERENCE BOOK(S):

Alan.S. Morris, (2002). *Principles of Measurement & instrumentation*, New Delhi: Prentice-Hall of India PVT Ltd. Print.

Albert D. Helfrick & William D., Cooper (2003). *Modern Electronic instrumentation & Measurement Techniques*, New Delhi: Prentice-Hall of India Pvt Ltd. Print.

George Kennedy, (2011). *Electronic Communication Systems*, (5th ed.), Singapore: McGraw Hill international editions. Print.

Kharate.G.K, (2010). *Digital Electronics*, New Delhi: Oxford University Press. Print.

Malvino A.P. & D.P. Leach, (2005). *Digital Principles & Applications*, New Delhi: Tata McGraw Hill Publishing Company Limited. Print.

Nagrath I.J., (2001). *Analog and Digital Electronics*, Prentice Hall of India. Print.

Nakra B.C. & Chaudhry K K., (2004). *Instrumentation, Measurement and Analysis,* (2nd ed.), New Delhi: Tata McGraw Hill Publising company Ltd. Print.

Paul Horowitz Winfred Hill., (2003). *The Art of Electronics,* (2nd ed.), Cambridge University Press. Print.

Robert Boylestad & Louis Nashelsky. A., (2001). *Electronic Devices & Circuit Theory,* (6th ed.), New Delhi: Prentice Hall of India. Print.

Theraja .B.L. & Sedha R.S., (2011). *Principles of Electronic Devices and Circuits,* (1st ed.), New Delhi: S.Chand & Company Ltd. Print.

PGP1502CM INTEGRATED ELECTRONICS			
Class	I M. Sc. Physics	**Semester**	I
Cognitive Level	K-3 Apply		
	K-4 Analyze		
	K-6 Create		

MAPPING: COs consistency with PSOs

PGP1502CM INTEGRATED ELECTRONICS					
CO/PSO	**PSO**				
	1	**2**	**3**	**4**	**5**
CO1	3	3	2	2	3
CO2	3	3	3	2	3
CO3	3	3	2	2	3
CO4	3	2	2	2	2
CO5	3	1	2	2	2

Strongly correlated (3), Moderately correlated (2), Weakly correlated (1)

PGP1401CM NUMERICAL METHODS WITH C

(THEORY)

COURSE OUTCOMES: **6 hrs./wk.**

On successful completion of the course, the student will be able to

CO1: identify instrumentation errors and calculate uncertainties

CO2: develop algorithms/C programs to solve real time problems

CO3: apply numerical methods to obtain approximate solutions to complex problems

CO4: analyze linear and nonlinear equations using regression methods

CO5: develop numerical solutions to integral and differential equations applied to natural systems

COURSE CONTENT:

UNIT I: ERROR ANALYSIS & INTRODUCTION TO C **18 hrs.**

Error Analysis – types of errors – types of uncertainties – propagation of uncertainties in compound quantities – static performance parameters – impedance loading and matching – specification of instrument static characteristics – selection of instrument – introduction – C operators – control instructions in C – decision control structure – *if-else* statement – loop control structure – *while* loop – *for* loop – *do-while* loop – case control structure – *switch.*

UNIT II: FUNCTIONS, ARRAYS AND FILES **18 hrs.**

Functions – passing values between functions – scope rule of functions – calling convention – one dicey issue – advanced features of functions – return type of function – call by value and call by reference – introduction to pointers – pointer notation – back to function calls – conclusions – recursion – recursion and stack – arrays – array initialization – bounds checking – passing array elements to a function – pointers and arrays – passing an entire array to a function – two dimensional array – initializing a 2D array – memory map of a 2D array – pointers and 2D arrays – pointer to an array – passing 2D array to a function – array of pointers – file input/output – data organization – file operations – opening a file – reading from a file – trouble in opening a file – closing the file – counting characters – tabs – spaces – a file copy program – writing to a file.

UNIT III: NUMERICAL SOLUTION OF EQUATIONS **18 hrs.**

Numerical algebraic and transcendental equations – introduction – beginning an iterative method – method of successive bisection – method of false position – Newton-Raphson iterative method – secant method – method of successive approximation – comparison of iterative methods – simultaneous linear algebraic equations – introduction – Gauss elimination method – pivoting – ill conditioned equations – refinement of solution obtained by Gaussian elimination – Gauss-Seidel iterative method – comparison of direct and iterative methods.

UNIT IV: INTERPOLATION, LEAST SQUARE APPROXIMATION OF FUNCTION **18 hrs.**

Introduction – Lagrange interpolation – difference tables – truncation error in interpolation – spline interpolation – least squares approximation of functions: introduction – linear regression – algorithm for linear regression – polynomial regression – fitting exponential and trigonometric functions – Taylor series representation.

UNIT V: NUMERICAL INTEGRATION AND ORDINARY DIFFERENTIAL EQUATIONS 18 hrs.

Numerical integration – Simpson's rule – algorithms for integration of tabulated function – algorithms for integrating a known function – Euler's method – Taylor series method – Runge-Kutta methods – predictor corrector method – higher order differential equations – comparison of predictor corrector method and Runge-Kutta methods.

TEXT BOOK(S):

Nakra B.C. & Chaudhry K. K., (2004). *Instrumentation, Measurement and Analysis,* (2nd ed.), New Delhi: Tata McGraw Hill Publishing Company Ltd. Print.

Chapters: 2.1 to 2.7.

Rajaraman V., (2005). *Computer Oriented Numerical Methods,* (3rd ed.), New Delhi: Prentice Hall of India Pvt. Ltd. Print.

Chapters: 3.1-3.8, 4, 5.1- 5.4, 6.1 - 6.5, 8.3, 8.4, 8.6, 8.7, 9.1 - 9.4.

Yashavant Kanetkar, (2009). *Let Us C,* (9th ed.), New Delhi: BPB publications. Print.

Chapters: 1, 2, 3, 4, 5, 8, 12.

REFERENCE BOOK(S):

Balagurusamy E., (2007). *Programming in ANSI C,* (4th ed.), New Delhi: Tata McGraw Hill Publishing Company Ltd., Print.

Jain M.K., Iyengar S.R.K. & Jain R.K., (2019). *Numerical methods for Scientific & Engineering Computation,* (6th ed.), New Delhi: Wiley Eastern. Print.

Mollah, S.A., (2011). *Numerical Analysis and Computational Procedures,* Kolkata: Arunbhasen Books and Allied Pvt. Ltd., Print.

Parthasarthy, S., (2008). *Essentials of programming in C for life sciences,* (2nd ed.), New Delhi: ANE books Pvt. Ltd., Print.

Venkataraman, M. K., (2001). *Numerical methods in Science and Engineering*, Chennai: The National Publishing, Co. Ltd. Print.

PGP1401CM NUMERICAL METHODS WITH C			
Class	I M.Sc., Physics	**Semester**	I
Cognitive Level	K-3 Apply		
	K-4 Analyze		
	K-6 Create		

MAPPING: COs consistency with PSOs

PGP1401CM NUMERICAL METHODS WITH C					
CO/PSO	**PSO**				
	1	**2**	**3**	**4**	**5**
CO1	3	1	3	1	3
CO2	3	3	3	2	3
CO3	3	3	3	1	3
CO4	3	3	3	1	3
CO5	3	3	3	1	3

Strongly correlated (3), Moderately correlated (2), Weakly correlated (1)

PGP1301CP GENERAL LAB I

(LAB)

COURSE OUTCOMES: **4 hrs./wk.**

On successful completion of the course, the student will be able to

CO1: identify the physics concepts behind the experiments

CO2: demonstrate the concepts involved in optics, electromagnetism and spectroscopy

CO3: measure the physical parameters with maximum accuracy

CO4: analyze the experimental data using analytical and graphical tools

CO5: interpret the results and prepare a technical report

COURSE CONTENT:

LIST OF EXPERIMENTS

(Any 10 experiments)

1. Determination of wavelength using grating by the method of Oblique incidence
2. Elliptic / Hyperbolic fringes
3. Characteristics of photo diode, photo transistor& photocell
4. Measurement of Planck's constant
5. Absorption of iodine spectrum
6. Measurement of volume susceptibility of a given liquid using Quincke's method / Guoy's apparatus
7. Determination of Hall coefficient using Hall setup.
8. Characteristics of optical fibers and losses in optical fiber
9. Energy gap determination of a semiconductor and thickness of thin film using Four probe method.
10. Chaos in a nonlinear circuit
11. Studies on the dielectric constants of solids.
12. Study of LR and LCR circuit.

Students are required to undertake a self-study on

- calibration and initial adjustments of measuring instruments
- documentation of physics principles behind the experiments

REFERENCE BOOKS:

Chattopadhyay D, Rakshit P.C., & Saha B, (2005). *An Advanced course in Practical Physics*, (7th ed.), Kolkata: New Central Book Agency Pvt. Ltd. Print.

Gupta S.L. & Kumar V., (2010). *Practical Physics with Viva-Voce*, (27th ed.), India: Pragati prakashan publishers. Print

PGP1301CP GENERAL LAB I			
Class	I M.Sc., Physics	**Semester**	1
Cognitive Level	K-3 Apply		
	K-4 Analyze		
	K-5 Evaluate		
	K-6 Create		

MAPPING: COs consistency with PSOs

PGP1301CP GENERAL LAB I					
CO/PO	PSO				
	1	2	3	4	5
CO1	3	3	1	3	3
CO2	3	3	1	3	3
CO3	3	3	2	1	3
CO4	3	3	3	3	3
CO5	3	1	3	3	3

Strongly correlated (3), Moderately correlated (2), Weakly correlated (1)

PGP2501CM MATHEMATICAL PHYSICS II

(THEORY)

COURSE OUTCOMES: **6 hrs./wk.**

On successful completion of the course, the student will be able to

CO1: interpret the theorems and axioms of Sets

CO2: employ Green's function to solve non-homogeneous boundary value problems and Interpret gamma and beta functions

CO3: solve differential equations using Laplace transform

CO4: apply Fourier analysis to periodic and non-periodic signals

CO5: use partial differential equations to predict the behavior of a vibrating string and heat transfer system

COURSE CONTENT:

UNIT I: INTRODUCTION TO GROUP THEORY **18 hrs.**

Concept of a group – abelian group – cyclic groups– group multiplication table – rearrangement theorem – subgroups: definition – co-sets – conjugate elements and classes – conjugate, normal and factor subgroups – isomorphism and homomorphism – permutation groups – group symmetry of an equilateral triangle and a square – representation of groups – reducible and irreducible representations –character of a representation: character tables – unitary groups – point groups.

UNIT II: GREEN'S FUNCTION, GAMMA AND BETA FUNCTION **18 hrs.**

Non-homogeneous boundary value problems and Green's function – Green's function for one dimensional problems – eigenfunction expansion of Green's function – Green's function for Poison's equation and a formal solution of electrostatic boundary value problems – gamma function – factorial and Gauss's Pi function – value of gamma(1/2) – graph of the gamma function – beta function – connection between beta and gamma function – important relation involving gamma functions.

UNIT III: LAPLACE TRANSFORMS **18 hrs.**

Laplace transform – inverse transform – linearity – s-shifting – transforms of derivatives and integrals – ordinary differential equations – unit step function – t shifting theorem – short impulses – Dirac's delta function – partial fractions – convolution – integral equations – differentiation and integration of transforms with variable coefficients.

UNIT IV: FOURIER SERIES, INTEGRALS AND TRANSFORMS **18 hrs.**

Fourier series – functions of any period – even and odd functions – half-range expansions – complex Fourier series – forced oscillations – Fourier integrals – Fourier cosine and sine transforms – Fourier transform: complex form of Fourier integral – Fourier transform and its inverse – physical interpretation – linearity – convolution.

UNIT V: PARTIAL DIFFERENTIAL EQUATIONS **18 hrs.**

Basic concepts – modeling: vibrating string – wave equation – solution by separation of variables – use of Fourier series – heat equation: solution by Fourier series – Fourier integrals and transforms.

TEXTBOOK(S):

Chattopadhyay P. K., (2008). *Mathematical Physics*, New Delhi: New Age International Publishers, Print.

Chapters: 6.1-6.3, 6.6.

Kreyszig E., (2013). *Advanced Engineering Mathematics*, (9th ed.), New Delhi: Wiley Eastern, Print.

Chapters: 6.1-6.6, 11.1-11.5, 11.7-11.9, 12.1-12.3, 12.5, 12.6.

Pipes L.A. & Harvill L. R., (2014). *Applied Mathematics for Engineers and Physicists*, (3rd ed.), Singapore: McGraw Hill Book Company. Print.

Chapters: Appendix B: 22-27.

Satya Prakash, (2010). *Mathematical Physics with Classical Mechanics*, New Delhi: Sultan Chand & Sons, Print.

Chapters: 13.1, 13.2, 13.4-13.9, 13.12-13.14, 13.16-13.19, 13.22, 13.25, 13.26.

REFERENCE BOOK(S)

Mary L. Boas, (2015). *Mathematical methods in the Physical Sciences*, (2nd ed.), New York: John Wiley & Sons. Print.

Mathews & Walker J., (2004). *Methods of Mathematical Physics*, New York: W.A. Benjamin Inc. Print.

Weber & Arfken, (2004). *Essential Mathematical Methods for Physicists*, United States: Academic Press. Print.

PGP2501CM MATHEMATICAL PHYSICS II	
Class: I M.Sc. Physics	**Semester:** II
Cognitive Level	K-2 Understand
	K-3 Apply
	K-6Create

MAPPING: COs consistency with PSOs

PGP2501CM MATHEMATICAL PHYSICS II					
CO/PSO	**PSO**				
	1	**2**	**3**	**4**	**5**
CO1	3	2	2	1	3
CO2	3	3	3	1	3
CO3	3	3	3	1	3
CO4	3	3	3	1	3
CO5	3	3	3	1	3

Strongly correlated (3), Moderately correlated (2), Weakly correlated (1)

PGP2401CM QUANTUM MECHANICS I

(THEORY)

COURSE OUTCOMES: **5 hrs./wk.**

On successful completion of the course the student will be able to

CO1: interpret wave function and obtain information about the position, momentum and energy of a particle

CO2: solve time independent Schrödinger equation for simple potentials

CO3: derive eigenfunctions and eigenvalues of various operators

CO4: apply three-dimensional Schrödinger equation to describe the behavior of hydrogen atom

CO5: analyse system of identical particles using quantum statistics

COURSE CONTENT:

UNIT I: WAVE FUNCTION **15 hrs.**

Schrödinger equation – statistical Interpretation of wave function – wavefunction collapse – probability: discrete variables – continuous variables – normalization – momentum – Ehrenfest theorem – uncertainty principle.

UNIT II: TIME INDEPENDENT SCHRÖDINGER EQUATION **15 hrs.**

Stationary states – infinite square well – harmonic oscillator: algebraic method – analytic method – free particle – delta-function potential: bound states and stationary states – delta-function potential – finite square well.

UNIT III: FORMALISM **15 hrs.**

Hilbert space – observables: Hermitian operators, determinate states – eigenfunctions of a Hermitian operator – generalized statistical interpretation: momentum space wave function – uncertainty principle – energy-time uncertainty principle – Dirac notation.

UNIT IV: QUANTUM MECHANICS IN THREE DIMENSIONS **15 hrs.**

Schrödinger equation in spherical coordinates: separation of variables – angular equation – radial equation – special case of infinite spherical well – hydrogen atom – angular momentum – spin: spin ½ – electron in a magnetic field– addition of angular momenta – Clebsch-Gordan coefficients.

UNIT V: IDENTICAL PARTICLES **15 hrs.**

Two-particle systems: bosons and fermions, exchange forces – atoms: helium – periodic table – solids: free electron gas – band structure – quantum statistical mechanics: example of a simple case – general case – most probable configuration – physical significance of α and β – black body spectrum.

TEXTBOOK(S):

Griffiths D. J., (2005). *Introduction to quantum mechanics,* (2nd ed.), New Delhi: Pearson Prentice Hall. Print.

Chapters: 1, 2, 3, 4, 5

REFERENCE BOOK(S):

Ghatak A. & Lokanathan S., (2007). *Quantum Mechanics: Theory and Applications*, (5th ed.), New Delhi: Macmilan India Ltd. Print.

Kakani S. L. & Chandalia H M., (2004). *Quantum Mechanics: Theory and Problems*, New Delhi: Sultan Chand & Sons. Print.

Mathews P. M. & Venkatesan K., (2010). *A Text book of Quantum Mechanics*, (2nd ed.), New Delhi: Tata McGraw Hill Education Private Ltd. Print.

Reed B. C., (2010). *Quantum Mechanics*, New Delhi: Jones and Bartlett India Pvt. Ltd. Print

Sakurai J. J., (2004). *Modern Quantum Physics*, New Delhi: Pearson Education (Singapore) Pt. Ltd. Print.

Shankar R., (2007). *Principles of Quantum Mechanics*, (2nd ed.), New Delhi: Springer (India) Private Ltd. Print.

PGP2401CM QUANTUM MECHANICS I		
Class: I M.Sc. Physics		**Semester:** II
Cognitive Level	K-2 Understand	
	K-3 Apply	
	K-4 Analyse	
	K-6 Create	

MAPPING: COs consistency with PSOs

PGP2401CM QUANTUM MECHANICS I					
CO/PSO	**PSO**				
	1	**2**	**3**	**4**	**5**

CO1	2	3	3	2	3
CO2	2	3	3	2	3
CO3	2	3	3	2	3
CO4	2	3	3	2	3
CO5	2	3	3	2	3

Strongly correlated (3), Moderately correlated (2), Weakly correlated (1)

PGP2402CM STATISTICAL MECHANICS AND THERMODYNAMICS

(THEORY)

COURSE OUTCOMES: **6 hrs./wk.**

On successful completion of the course, the student will be able to

CO1: describe the laws of thermodynamics and its consequences

CO2: classify the types of ensembles in classical statistics

CO3: explain the phase transformations and transport phenomena of a system

CO4: apply quantum statistics to systems of indistinguishable particles

CO5: discuss the theory of blackbody radiation

COURSE CONTENT:

UNIT I: LAWS OF THERMODYNAMICS AND THEIR APPLICATIONS **18 hrs.**

Work and internal energy – heat – absolute temperature – heat capacity and specific heat – entropy – extensive and intensive parameters – equation of state and internal energy – specific heats – adiabatic expansion or compression – entropy – derivation of general relations – summary of Maxwell relations and thermodynamic functions – specific heats – entropy and internal energy – free expansion of a gas – heat engines – refrigerators.

UNIT II: CLASSICAL STATISTICS **18 hrs.**

Isolated system – system in contact with a heat reservoir – simple applications of the canonical distribution – system with specified mean energy – calculation of mean values in a canonical ensemble – connection with thermodynamics –grand canonical and other ensembles – partition functions and their properties – calculation of thermodynamic quantities – Gibbs paradox – equipartition theorem proof of the theorem – simple applications: mean kinetic energy of a molecule in a gas – Brownian motion – harmonic oscillator.

UNIT III: PHASE TRANSITION AND TRANSPORT PHENOMENA **18 hrs.**

Equilibrium between phases – equilibrium conditions and Clausius-Clapeyron equation – phase transformations of a simple substance – approximate calculations of vapor pressure – phase transformations and equation of state – general relations for a system with several components – alternative discussion of equilibrium between phases – general conditions for chemical equilibrium – chemical equilibrium between ideal gases – transport phenomena – viscosity – thermal conductivity – self diffusion – electrical conductivity.

UNIT IV: QUANTUM STATISTICS **18 hrs.**

Identical particles and symmetry requirements – formulation of statistical problem – quantum distribution function – Maxwell-Boltzmann statistics – photon statistics – B-E statistics – F-D statistics – quantum statistics in classical limit – Quantum states of a single particle – evaluation of partition function – physical implications of quantum mechanical enumeration of states – partition functions of polyatomic molecules.

UNIT V: BLACK BODY RADIATION **18 hrs.**

Electromagnetic radiation in thermal equillibria inside an enclosure – Nature of radiation inside an arbitrary enclosure – radiation emitted by a body at temperature T – consequences of F-D distribution – quantitative calculation of electronic specific heat.

TEXTBOOK(S):

Reif F., (2010). *Fundamentals of Statistical and Thermal physics*, Howrah: Sarat Impressions Pvt. Ltd. Print.

Chapters: 4.1-4.5, 4.7. 5.1-5.9, 5.11,5.12, 6.1 – 6.6, 6.9, 6.10, 7.1- 7.3, 7.5, 7.6, 8.5-8.10, 9.1-9.17, 12.3-12.6,

REFERENCE BOOK(S):

Agarwal B.K. & Eisner M., (2000). *Statistical Mechanics*, New Delhi: Wiley Eastern Ltd. Print.

Kerson Huang, (2003). *Statistical Mechanics*, (2nd ed.), New York: John Wiley & Sons. Print.

Pathria K. & Paul D. Beale, (2015). *Statistical Mechanics*, (3rd ed.), India: Elsevier. Print.

PGP2402CM STATISTICAL MECHANICS AND THERMODYNAMICS		
Class: I M.Sc. Physics		**Semester:** II
Cognitive Level	K-2 Understand	
	K-3 Apply	
	K-4 Analyse	

MAPPING: COs consistency with PSOs

PGP2402CM STATISTICAL MECHANICS AND THERMODYNAMICS					
CO/PSO	**PSO**				
	1	**2**	**3**	**4**	**5**
CO1	3	2	1	2	1
CO2	3	2	1	1	1
CO3	3	2	1	1	2
CO4	3	3	1	1	1
CO5	3	3	1	2	1

Strongly correlated (3), Moderately correlated (2), Weakly correlated (1)

PGP2301CT RESEARCH METHODOLOGY

(LAB CUM THEORY)

COURSE OUTCOMES: **3T + 1L hrs./wk.**

On successful completion of the course, the student will be able to

CO1: define a research problem

CO2: classify research methods and reduce random errors in experiments

CO3: analyse data using statistical methods

CO4: make use of appropriate tools to prepare graphs and documents

CO5: write scientific reports

COURSE CONTENT:

UNIT I: FORMULATION OF RESEARCH PROBLEM **12 hrs.**

Objectives of research – types of research – research approaches – significance of research – research methods versus methodology – research process – criteria of good research – selecting the problem – technique involved in defining a problem.

UNIT II: EXPERIMENTAL DESIGN AND ERROR ANALYSIS **12 hrs.**

Need for scientific inquiry – research methods for science: Hypothesis-driven research – experimental research – theoretical research – observational and exploratory research – hypothesis-driven experiments – random error – systematic error – precision and accuracy – propagation of error.

UNIT III: STATISTICAL ANALYSIS **12 hrs.**

Mean – median – standard deviation – probability distribution: discrete probability distributions – continuous probability distributions – connecting data and probability distributions: sampling – true mean and true standard deviation – central limit theorem – brief introduction to machine language: definition – need – types – simple application.

UNIT IV: GRAPHING AND TYPESETTING TOOLS (LAB) **12 hrs.**

Basics of gnuplot: functions – plot and splot commands – customizing plots – plotting data files – gnuplot scripts – curve-fitting – multiplot – exponential smoothing – saving and exporting – typesetting using LaTex: basics – document structure – typesetting text – tables – figures – equations – inserting references using Mendeley.

UNIT V: SCIENTIFIC REPORT WRITING **12 hrs.**

Writing a proposal – writing scientific papers – scientific figures – scientific presentation – searching for scientific information – obtaining scientific articles – reading scientific papers – plagiarism – understanding research metrics: impact factor – citation index – h-index – safety and ethics.

TEXTBOOK(S):

Kothari C.R., (2004). *Research Methodology: Methods & Techniques*, (2nd ed.), New Delhi: New Age International Pvt. Ltd. Print.

Chapter:1 (pp. 2-8, 10-21), Chapter: 2 (pp. 25-29)

Michael P. Marder, (2011). *Research Methods for Science*, (1st ed.), New York: Cambridge University Press. Print.

Chapters: 1.2, 1.3, 2.1, 2.2, 2.4, 3.2.1, 3.2.2, 3.2.4, 3.3, 3.4, 3.6 (pp. 81-83), 5, Appendix A, C.1

http://www.ap.smu.ca/~thacker/teaching/3437/gnuplot.pdf

isidore.co › calibre › get › pdf › Gnuplot in Action (2nd ed.)_6019.pdf

http://www.docs.is.ed.ac.uk/skills/documents/3722/3722-2014.pdf

https://www.bu.edu/math/files/2013/08/ShortTeX3.pdf

https://editorresources.taylorandfrancis.com/understanding-research-metrics/

https://nsufl.libguides.com/c.php?g=469502&p=3209467

https://www.researchgate.net/publication/283831577_Step-by-Step_Procedure_to_Cite_References_from_Mendeley_and_Reference_Management_Software_in_LaTeX_Journal_Articles_Conference_Papers_Thesis_Dissertations_and_Research_Proposals doi:10.13140/RG.2.1.4370.3767/3

REFERENCE BOOK(S):

Rajasekar S., Philominathan P. & Chinnathambi V., (2013). *Research Methodology*, arXiv:physics/0601009v3 [physics.gen-ph]

Kate Kirby & Frances A. Houle, (2004). *Ethics and the Welfare of the Physics Profession*, Physics Today,57, 11, 42.: doi: 10.1063/1.1839376

WEBSITE(S):

https://biblioteca.unileon.es/files/Mendeley%20and%20BibTeX%20into%20LaTeX.pdf

http://lowrank.net/gnuplot/index-e.html

http://personalpages.to.infn.it/~mignone/Numerical_Algorithms/gnuplot.pdf

https://www.usm.uni-muenchen.de/CAST/talks/gnuplot.pdf

http://www.usm.unimuenchen.de/people/puls/lessons/intro_general/gnuplot/gnuplot_for_beginners.pdf

https://www.maths.tcd.ie/~dwilkins/LaTeXPrimer/GSWLaTeX.pdf

https://writingcenter.unc.edu/tips-and-tools/scientific-reports/

https://www.waikato.ac.nz/library/study/guides/write-scientific-reports

https://physicstoday.scitation.org/doi/pdf/10.1063/1.1839376

https://towardsdatascience.com/machine-learning-intuition-for-beginners-ba07a640d928

https://www.tutorialspoint.com/machine_learning/machine_learning_tutorial.pdf

https://arxiv.org/pdf/1808.02342.pdf

https://www.toptal.com/machine-learning/machine-learning-theory-an-introductory-primer

http://disp.ee.ntu.edu.tw/~pujols/Machine%20Learning%20Tutorial.pdf

https://machinelearningmastery.com/machine-learning-in-python-step-by-step/

PGP2301CT RESEARCH METHODOLOGY		
Class: I M.Sc. Physics		**Semester:** II
Cognitive Level	K-1 Remember	
	K-2Understand	
	K-3Apply	
	K-4 Analyse	
	K-6Create	

MAPPING: COs consistency with PSOs

PGP2301CT RESEARCH METHODOLOGY					
CO/PSO	**PSO**				
	1	**2**	**3**	**4**	**5**
CO1	3	3	1	1	2
CO2	3	3	1	1	2
CO3	3	3	3	2	3
CO4	3	1	1	3	3
CO5	3	1	1	3	3

Strongly correlated (3), Moderately correlated (2), Weakly correlated (1)

PGP2301CP ELECTRONICS LAB

(LAB)

COURSE OUTCOME: **3 hrs./wk.**

On successful completion of the course, the student will be able to

CO1: recall the theoretical concepts behind the experiments

CO2: design the analog and digital circuits using transistors, op-amps and logic gates

CO3: analyse the role of transistors, op-amps, transducers and logic gates in analog and digital electronics

CO4: develop analytical skills for interpreting the data

CO5: write an effective lab report with meaningful conclusions

COURSE CONTENT:

EXPERIMENTS / LAB EXERCISES: **45 hrs.**

ANALOG EXPERIMENTS: (Any 3 Experiments)

1. Linear Op-amp Applications (inverting / noninverting / differential configurations)
   - Summing, Difference, Scaling and averaging amplifiers
2. Study of Low Pass, Band pass & High Pass filters using op -amps
3. Study of Wienbridge / Phase shift oscillator using op-amps

4. Non-linear Applications of Op-amp using an open source software (any two of the following experiments)
    - Exponential amplifier/ Logarithmic amplifier
    - Square/square root amplifier
    - Cube/cube root amplifier

DIGITAL EXPERIMENTS: (Any 4 Experiments)

5. Arithmetic & Logic unit
6. Digital Comparator
7. Encoders & decoders
8. Multiplexer / De-multiplexer
9. Parity Checker / Generator

EXPERIMENTS IN TRANSDUCERS & COMMUNICATION ELECTRONCIS:

10. Study of Linear Variable Differential Transducer (LVDT)
11. Study of Transducer using Strain Gauge
12. Study of Amplitude modulator and demodulator circuits

Open source software like LT Spice can be employed

REFERENCE BOOK(S):

Dennis Roddy and John Coolen, (2008). *Electronic Communications*, (4th ed.), New Delhi: Pearson Education, Print.

Jain R. P., (2010). *Modern Digital Electronics*, (4th ed.), New Delhi: Tata McGraw-Hill Publishing company Ltd., Print.

Kalsi H.S., (2009). *Electronic Instrumentation*, (2nd ed.), New Delhi: Tata McGraw-Hill Publishing Company Ltd., Print.

Malvino, (2005). *Electronic Principles*, (6th ed.), New Delhi: Tata McGraw-Hill Publishing Company Ltd., Print.

Ramakant A. Gayakwad, (2001). *Op-amps and linear integrated circuits*, (4th ed.), New Delhi: Prentice Hall of India. Print.

WEBSITE(S):

http://www.editorialdigitaltecdemonterrey.com/materialadicional/id212/cap1/LTSpiceGuide.pdf

http://qucs.sourceforge.net/docs/tutorial/getstarted.pdf

PGP2301CP ELECTRONICS LAB		
Class: I M.Sc. Physics		**Semester:** II
Cognitive Level	K-1 Remember	
	K-4 Analyse	
	K-6 Create	

MAPPING: COs consistency with POs and PSOs

PGP2301CP ELECTRONICS LAB					
CO/PSO	**PSO**				
	1	**2**	**3**	**4**	**5**
CO1	3	3	2	2	3
CO2	3	3	2	2	3
CO3	3	3	1	3	3
CO4	3	3	1	1	2
CO5	3	0	1	3	2

Strongly correlated (3), Moderately correlated (2), Weakly correlated (1)

PGP2201EI INTRODUCTION TO GEOGRAPHICAL INFORMATION SYSTEM

(THEORY)

COURSE OUTCOMES: **4 hrs./wk.**

On successful completion of the course the student will be able to

CO1: explain the principles of geographical information system

CO2: extend data editing to create geo database in GIS

CO3: employ modelling methods of GIS in spatial mapping

CO4: recognise the basics of GPS and its techniques

CO5: make use of GIS software for real time applications

COURSE CONTENT:

UNIT I: FUNDAMENTALS OF GIS **12 hrs.**

Map – computer assisted mapping – components of GIS – data used in GIS – characteristics of spatial data – sources of spatial and attribute data – data structure: raster and vector – database management system: object oriented – relational database model – integrating spatial and attribute data – modeling third and fourth dimension.

Activity: Google earth: Pinning a particular place, marking measurement and onscreen digitization

UNIT II: DATA EDITING AND ANALYSIS **12 hrs.**

Data editing: checking and correcting errors in spatial and attribute data – transformation – generalization – edge matching – rubber sheeting – building geo database – Analysis: measurement of length, perimeter and area – queries – reclass – buffer – overlay – spatial interpolation – surface analysis – network analysis.

Activity: Creation of Geo database using open source GIS software

UNIT III: DATA MODELLING **12 hrs.**

Models – process modeling and GIS – modeling physical and environmental process – modeling human processes – modeling decision making process – problems in using GIS in spatial modeling process – Output: Maps as an output – thematic maps – non-cartographic output – spatial multimedia – mechanisms of delivery.

Activity: Creation of surface modeling like DEM, TIN, slope and aspect using open source software

UNIT IV: GPS AND ITS APPLICATIONS **12 hrs.**

Introduction – history of GPS – advantages and limitations of GPS – segments of GPS: control segment – space segment – user segment – Geo positioning: point – relative – static – kinematic – different GPS systems – GPS surveying – sources of error – error correction – GPS applications.

Activity: Handling GPS receiver / Smart phone

UNIT V: APPLICATION OF GIS **12 hrs.**

Natural resources and disaster management – environmental studies – land use / land cover planning – urban studies – military – civil engineering – agriculture – navigation and location-based services – facilities management.

Activity: Change detection Analysis using open source GIS software

TEXTBOOK(S):

Ahmed el Rabbany, (2002). *Engineer's Guide to GPS (Mobile Communications Library),* (1st ed.), Artech House Publishers.

Chapters: 1.1, 1.2, 1.3, 1.6, 1.7, 1.8, 3, 10.

Ian Heywood, Sarah Cornelivs & Steve Carver, (2007). *An Introduction to Geographical Information System,* New Delhi: Pearson Education Pvt. Ltd. Print.

Chapters: 1, 3, 5, 6, 7, 8.

REFERENCE BOOK(S):

Peter A. Burrough & Rachael A. Mc. Donnell, (2004). *Principles of Geographical Information System*, New York: Oxford University Press Inc. Print.

LO. C.P. & Albert K.W. Yeung, (2006). *Concepts and Techniques of Geographic Information Systems*, New Delhi: Prentice-Hall of India. Print.

Satheesh Gopi, (2005). *Global Positioning System Principles and Applications*, New Delhi: Tata McGraw-Hill Publishing Company Limited. Print.

WEBSITE(S):

https://www.colorado.edu/geography/gcraft/notes/gps/gps_f.html

http://www.asiannature.org/sites/default/files/Qgis tutorial compiled.pdf

http://www.aun.edu.eg/megwrm/sub/workshop5/pdf/ilwis_user_guide30.pdf

PGP2201EI INTRODUCTION TO GEOGRAPHICAL INFORMATION SYSTEM	
Class: I M.Sc. Physics	**Semester:** II
Cognitive Level	K-2 Understand
	K-3 Apply

PGP3302CP COMPUTATIONAL AND GEOINFORMATICS LAB

(LAB)

COURSE OUTCOMES: **3 hrs./wk.**

On successful completion of the course, the student will be able to

CO1: formulate and perform quantum chemical calculations using quantum espresso

CO2: analyse and interpret the material properties

CO3: interpret the different bands used in geospatial data

CO4: examine the satellite images and perform spectral analysis

CO5: relate concepts of Physics in open remote sensing environment

COURSE CONTENT: **45 hrs.**

1. Determination of the geometrical parameter of the optimized geometry of a molecule
2. Convergence tests for energy cut off and Brillouin zone sampling
3. Determination of the equilibrium lattice parameter and bulk modulus of silicon
4. Determination of the band structure of silicon
5. Density of states and band structure calculations for aluminium

GEOINFORMATICS LAB

1. **Image appreciation**

   Satellite image - FCC, Thermal, Microwave & Hyper spectral

2. **DN to radiance conversion**

   Converting DNs (for each band) – Radiance – Radiance to Reflectance

3. **Fourier analysis**

   Low pass - High pass filter

4. **Spectral reflectance analysis**

   Vegetation – Soil – Water indices

5. **Change detection and Accuracy assessment**

   Raster calculator – Feature compare – Correlation

REFERENCE BOOK(S):

Frisch, Eleen, Michael, J. Frisch & Gary, W. Trucks, (2005). *Gaussian 03 User's Reference*, (2nd ed.), United States: Gaussian Inc., Print.

Giannozzi, Paolo, Ballabio, Gerardo & Cavazzoni, Carlo. *User's Guide for Quantum ESPRESSO*.

Kang – Tsung Chang, (2016). *Introduction to Geographical Information Systems*, (4th ed.), New Delhi: Tata McGraw Hill. Print.

Michael N. DeMers, (2009). *Fundamentals of geographic information systems*, New York: John Wiley & Sons.

LAB MANUAL:

ERDAS Field Guide, (2003), Leica Geosystems, (7th ed.)

Manuals for GRASS, QGIS, ILWIS

WEBLINK(S):

University of Colorado Boulder.(2006, April 10).*Band Structure* [Video file]. Retrieved from https://www.oercommons.org/courses/band-structure.CC BY license.

Delft University of Technology. (2016, February 15). *Introduction to Remote Sensing and Visible RS*[Video file]. Retrieved from https://ocw.tudelft.nl/course-lectures/introduction-to-remote-sensing-and-visible-rs/. CC BY-NC-SA license.

PGP3302CP COMPUTATIONAL AND GEOINFORMATICS LAB		
Class: II M. Sc. Physics		**Semester:** III
Cognitive Level	K - 3 Apply	
	K - 4 Analyse	
	K - 6 Create	

MAPPING: COs consistency with PSOs

PGP3302CP COMPUTATIONAL AND GEOINFORMATICS LAB					
CO/PSO	**PSO**				
	1	**2**	**3**	**4**	**5**
CO1	3	3	3	1	3
CO2	3	3	1	1	3
CO3	1	2	3	3	1
CO4	3	2	3	3	3
CO5	3	2	3	3	3

Strongly correlated (3), Moderately correlated (2), Weakly correlated (1)

PGP3401CM QUANTUM MECHANICS II

(THEORY)

COURSE OUTCOMES: **5 hrs./wk.**

On successful completion of the course, the student will be able to

CO 1: describe the quantum mechanical formulations using time independent perturbation theory

CO 2: employ variational principle and WKB approximation to quantum mechanical systems

CO 3: analyse perturbed quantum mechanical systems using time dependent perturbation theory

CO 4: explain quantum scattering theory based on partial wave analysis and Born approximation

CO 5: interpret relativistic wave equations in quantum mechanics

COURSE CONTENT:

UNIT I: TIME INDEPENDENT PERTURBATION THEORY **15 hrs.**

Nondegenerate perturbation theory: general formulation – first order theory – second order energies – degenerate perturbation theory: two-fold degeneracy – higher order degeneracy – fine structure: relativistic correction – spin-orbit coupling – Zeeman effect – hyperfine splitting.

UNIT II: VARIATIONAL PRINCIPLE AND WKB APPROXIMATION **15 hrs.**

Theory of variational principle – ground state energy of 1D harmonic oscillator – delta function potential – infinite square well – ground state of helium – hydrogen molecule ion – WKB approximation – classical region – potential well with two vertical walls – tunneling – Gamow's theory of α-decay – connection formulas – examples: potential well with one and no vertical walls.

UNIT III: TIME DEPENDENDENT PERTURBATION THEORY **15 hrs.**

Two-level systems: perturbed system – zeroth, first and second order approximations – sinusoidal perturbations – emission and absorption of radiation: electromagnetic waves – absorption – stimulated and spontaneous emission – incoherent perturbations – Einstein's A and B coefficients – life time of an excited state – selection rules – adiabatic approximation – adiabatic theorem.

UNIT IV: SCATTERING **15 hrs.**

Classical scattering theory – hard sphere scattering – quantum scattering theory – partial wave analysis: formalism – strategy – quantum hard sphere scattering – phase shifts – Born approximation: integral form of Schrödinger equation – first born approximation – low energy soft-sphere scattering – Yukawa scattering – Rutherford scattering – Born series.

UNIT V: RELATIVISTIC QUANTUM MECHANICS **15 hrs.**

Klein-Gordon equation – interpretation of Klein-Gordon equation – particle in coulomb field – Dirac equation for free particle – Dirac matrices – probability density – plane wave solutions – negative energy states – spin of Dirac particle – magnetic moment of electron – spin-orbit interaction.

TEXTBOOK(S):

Griffiths D J., (2005). *Introduction to Quantum Mechanics*, (2nd ed.), New Delhi: Pearson Prentice Hall. Print.

Chapters: 6,7,8,9,10,11.

Aruldhas G., (2002). *Quantum Mechanics,* New Delhi: Prentice-Hall of India Pvt. Ltd. Print.

Sections: 15.1–15.5, 15.7–15.12

REFERENCE BOOK(S):

Ghatak A. & Lokanathan S., (2007). *Quantum Mechanics: Theory and Applications,* (5thed.), New Delhi: Macmilan India Ltd. Print.

Kakani S.L. & Chandalia H.M., (2004). *Quantum Mechanics: Theory and Problems,* New Delhi: Sultan Chand & Sons. Print.

Mathews P.M. & Venkatesan K., (2010). *A Text Book of Quantum Mechanics*, (2nd ed.), New Delhi: Tata McGraw Hill Education Private Ltd. Print.

Reed B.C., (2010). *Quantum Mechanics*, New Delhi: Jones and Bartlett India Pvt. Ltd.

Sakurai J.J., (2004). *Modern Quantum Physics*, New Delhi: Pearson Education Pvt. Ltd. Print.

Shankar R., (2007). *Principles of Quantum Mechanics*. (2nd ed.). New Delhi: Springer (India) Pvt. Ltd. Print.

WEBLINK(S):

Rene Yves Rasoanaivo. (2018) Quantum Mechanics, Retrieved from https://oer.avu.org/handle/123456789/796. CC-BY, SA 4.0 license

Lindau Nobel Laureate Meetings. (2018, April 13) *Quantum Mechanics*, [Video file]. Retrieved from https://www.oercommons.org/courses/quantum-mechanics-2-2015/view CC BY-NC-ND license.

PGP3401CM QUANTUM MECHANICS II	
Class: II M. Sc. Physics	**Semester:** III
Cognitive Level	K-2 Understand
	K-3 Apply
	K-4 Analyse

MAPPING: COs consistency with PSOs

PGP3401CM QUANTUM MECHANICS II					
CO/PSO	**PSO**				
	1	**2**	**3**	**4**	**5**
CO1	3	3	2	1	3
CO2	3	3	2	1	3
CO3	3	3	2	1	3
CO4	3	3	2	1	3
CO5	3	3	1	1	2

Strongly correlated (3), Moderately correlated (2), Weakly correlated (1)

PGP3402CM ELECTROMAGNETIC THEORY

(THEORY)

COURSE OUTCOMES: **6 hrs. / wk.**

On successful completion of the course, the student will be able to

CO1: apply the knowledge of vector calculus in solving electromagnetic vector field

CO2: analyse the boundary value problems involving dielectric and magnetic materials

CO3: appraise the forms of Maxwell's equation in various material media

CO4: employ electromagnetic wave equation in different media

CO5: infer the relativistic perspective for the nature of electromagnetic fields

COURSE CONTENT:

UNIT I: ELECTROSTATISTICS **18 hrs.**

Poisson's equation – Laplace's equation – Laplace's equation in one independent variable – solutions to Laplace's equation in spherical coordinates, zonal harmonics – conducting sphere in a uniform electric field – cylindrical harmonics – Laplace's equation in rectangular coordinates – Laplace's equation in two dimensions: general solution – electro static images – point charge and conducting sphere – line charges and line images – system of conductors – coefficients of potential – solutions of Poisson's equation.

UNIT II: ELECTROSTATIC FIELD IN DIELECTRIC MEDIA **18 hrs.**

Polarization – field outside of a dielectric medium – electric field inside a dielectric – Gauss's law ina dielectric: electric displacement – electric susceptibility and dielectric constant – point charge in a dielectric fluid – boundary condition on field vectors – boundary value problems involving dielectrics – dielectric sphere in a uniform electric field – force on a point charge embedded in a dielectric.

UNIT III: MAGNETIC FIELD AND MAXWELL'S EQUATION **18 hrs.**

Magnetic vector potential – magnetic field of a distant circuit – magnetic scalar potential – magnetic flux – magnetization –magnetic field produced by magnetized material – sources of magnetic field, magnetic intensity – field equations – magnetic susceptibility and permeability – hysteresis – boundary conditions on field vectors – boundary value problems involving magnetic materials – generalization of Ampere's law, displacement current – Maxwell's equations and their empirical basis – electromagnetic energy – wave equation – boundary conditions – wave equation with sources.

UNIT IV: ELECTROMAGNETIC WAVES **18 hrs.**

Plane monochromatic waves in non conducting media – polarization – energy density and flux – plane monochromatic waves in conducting media – spherical waves – reflection and refraction at the boundary of two non- conducting media – normal incidence and oblique incidence – Brewster's angle – critical angle – complex Fresnel coefficients – reflection from a conducting plane – reflection and transmission by a thin layer interference – propagation between parallel conducting plates – wave guides – cavity resonators.

UNIT V: ELECTRODYNAMICS AND SPECIAL THEORY OF RELATIVITY **18 hrs.**

Lienard-Wiechert potentials – field of a uniformly moving point charge – field of an accelerated point charge – Lorentz transformation and Einstein's postulates of special relativity – geometry of space time – Lorentz transformation as an orthogonal transformation – covariant form electromagnetic equations – transformation law for electromagnetic field – field of a uniformly moving point charge – radiation from an oscillating dipole – radiation from a half wave antenna – radiation from a group of moving charges.

TEXTBOOK(S):

John R. Reitz, Frederick J. Milford & Robert W. Christy, (2010). *Foundations of Electromagnetic theory,* (4th ed.), India: Dorling Kindersley India Pvt. Ltd. Print.

Chapters: 3, 4, 8.6 – 8.9, 9.1, 9.2, 9.4 – 9.8,16.1-16.4,16.6- 16.8, 17,18, 20.1– 20.3, 21.1 -21.3, 22.2 -22.7

REFERENCE BOOK(S):

Bhag Singh Guru & Huseyin R. Hiziroglu, (2008). *Electromagnetic Field Theory Fundamentals,* (2nd ed.), United Kingdom: The Press Syndicate of the University of Cambridge. Print.

Feynman, Leighton & Sands, (2013). *The Feynman Lectures on Physics,* (Vo.II), India: Dorling Kindersley India Pvt. Ltd. Print.

John D. Kraus & Daniel A. Fleisch, (2011). *Electromagnetics with Applications,* (5th ed.), New Delhi: Tata Mcgraw-Hill. Print.

Saroj Kumar Dash & Smruti Ranjan Khuntia, (2010). *Fundamentals of Electromagnetic Theory,* New Delhi: PHI Learning Private Limited. Print.

Saxena A.K., (2009). *Electromagnetic Theory and Applications,* New Delhi: N. K. Mehra for Narosa Publishing House Pvt. Ltd. Print.

WEBSITE(S):

http://www.oup.com/us/catalog/general/subject/Physics/ElectricityMagnetism/view=usa&sf=all

http://www.kineticbooks.com/physics/16997/17000/sp.htmlhttp://www.ftschool.org/fourth/science/electric –magnet.html http://www – istp.gsfc.nasa.gov/Education/magnet.htmlhttp://www.sciencemadesimple.net/static.html http://www.reprise.com/host/electricity/default.asp

WEBLINK(S):

Steven Ellingson W. (2018) *Electromagnets.* Retrieved from https://www.oercommons.org/courses/electromagnetics-volume-1/view. CC BY-SA 4.0 license.

John F. Cochran BretislavHeinrich (2004) *Applications of Maxwell's Equations.* Retrieved from https://www.oercommons.org/courses/applications-of-maxwell-s-equations/view. CC BY- 4.0 license.

PGP3402CM ELECTROMAGNETIC THEORY	
Class: II M.Sc. Physics	**Semester:** III
Cognitive Level	K-3 – Apply
	K-4 - Analyse
	K-5 – Evaluate

MAPPING: COs consistency with PSOs

PGP3402CM ELECTROMAGNETIC THEORY					
CO/PSO	**PSO**				
	1	**2**	**3**	**4**	**5**
CO1	3	3	2	1	1
CO2	3	3	3	1	1
CO3	3	1	1	2	2
CO4	3	2	2	1	2
CO5	3	1	1	2	2

Strongly correlated (3), Moderately correlated (2), Weakly correlated (1)

PGP3402MO PHYSICS FOR GEOINFORMATICS

(THEORY)

COURSE OUTCOMES: **5 hrs./wk.**

On successful completion of the course, the student will be able to

CO1: recognise the basic concepts of physics in remote sensing

CO2: identify the role of electromagnetic radiation with matter in remote sensing system

CO3: decide the suitable sensors for remote sensing applications

CO4: classify the multi and hyper spectral images

CO5: make use of remote sensing technique for various earth resource applications

COURSE CONTENT:

UNIT I: ELECTROMAGNETIC RADIATION **15 hrs.**

Remote sensing system – concept of signature – remote sensors – platforms – data products – data analysis – velocity of EM radiation – polarization – coherent radiation – propagation of EM waves from one medium to another – diffraction – doppler effect – attenuation – quantum nature of EM radiation – source of EM radiation.

UNIT II: INTERACTION OF EMR WITH ATMOSPHERE AND EARTH'S SURFACE FEATURES 15 hrs.

Energy source and radiation principle – electromagnetic spectrum – energy interaction in the atmosphere – scattering –Rayleigh-Mie nonselective scattering – absorption– refraction – atmospheric windows – energy interaction with earth surface – energy balance equation – spectral reflectance – spectral response – spectral reflectance curves for vegetation, soil and water – factors affecting spectral reflectance.

UNIT III: PLATFORMS AND SENSORS 15 hrs.

Ground based platforms – airborne platforms – space borne platforms – principles of satellite motion – sun synchronous and geosynchronous orbits – spacecraft – resolution concept – scanners – opto-mechanical scanners – along and across track scanning – collecting optics – spectral dispersion system – detectors.

UNIT IV: MULTISPECTRAL AND HYPERSPECTRAL SATELLITE SYSTEMS 15 hrs.

Earth resource satellites – landsat satellite overview – landsat series – data continuity mission – future of landsat program – spot satellite program – spot series – other earth resource satellites – IRS series – moderate resolution systems – high resolution systems – hyperspectral sensing – hyperspectral satellite system – Radar development – lidar system – operating principles – LiDAR data characteristics – comparison with RADAR.

UNITV: APPLICATIONS OF GEOINFORMATICS 15 hrs.

Earth resource management – environmental studies – disaster management – utilities management – urban studies – military applications – navigation – location-based services – civil engineering – agriculture.

TEXTBOOK(S):

George Joseph & Jeganathan C., (2018). *Fundamentals of Remote Sensing*, (3rd ed.), Hyderabad: Universities Press, Print.

Chapters.: 1.2, 1.3, 2.1 - 2.6, 2.8, 6.5, 8.1, 8.3 – 8.5, 11

Lillesand M. Thomas, Ralph W. Kiefer & Jonathan W. Chipman, (2014). *Remote Sensing and Image Interpretation*, (6th ed.), New York: John Wiley & Sons, Print.

Chapters.: 1.2 – 1.4, 5.2, 5.3, 5.8, 5.14, 6.1, 6.3 – 6.16, 8.2, 8.23

REFERENCE BOOK(S):

Anij Reddy M, (2008). *Textbook of Remote Sensing and Geographical Information systems*, (3rd ed.), Hyderabad: B S Publications, Print.

Jensen R. John, (2007). *Remote Sensing of the Environment: An Earth Resource Perspective*, (2nd ed.), New Delhi: Pearson Education. Print.

Floyd F. Sabins, (2007). *Remote Sensing Principles and Interpretation,* (3rd ed.), United states of America: W.H. Freeman and Company.

WEBLINK(S):

Delft University of Technology. (2016, February 15). *Introduction to Remote Sensing and Visible RS* [Video file]. Retrieved from https://ocw.tudelft.nl/course-lectures/introduction-to-remote-sensing-and-visible-rs/ CC BY NC-SA license.

National Ecological Observatory Network. (2015, March 19). *Mapping the Invisible: Introduction to Spectral remote Sensing*[Video file]. Retrieved from https://youtu.be/3iaFzafWJQE. CC BYCreative

Commons Attribution license.

PGP3402MO PHYSICS FOR GEOINFORMATICS		
Class: II M. Sc. Physics		**Semester:** III
Cognitive Level	K - 2 Understand	
	K - 3 Apply	
	K - 4 Analyse	
	K - 5 Evaluate	

MAPPING: COs consistency with PSOs

PGP3402MO PHYSICS FOR GEOINFORMATICS					
CO/PSO	**PSO**				
	1	**2**	**3**	**4**	**5**
CO1	3	3	2	3	3
CO2	3	2	2	3	2
CO3	3	3	2	3	2
CO4	2	3	2	3	3
CO5	3	3	3	3	3

Strongly correlated (3), Moderately correlated (2), Weakly correlated (1)

PGP3501CM SOLID STATE PHYSICS

(THEORY)

COURSE OUTCOMES: **6 hrs./wk.**

On successful completion of the course, the student will be able to

CO1: describe the crystal structure and symmetry in real and reciprocal space

CO2: interpret the elastic vibrations of crystals and the thermal properties of phonons

CO3: apply the free electron theory to solids to describe electronic behavior

CO4: compare normal and superconductors and understand the phenomenon of superconductivity

CO5: explain ferromagnetism, consequences of dislocation and point defects in a crystal

COURSE CONTENT:

UNIT I: CRYSTAL STRUCTURE, BINDING AND ELASTIC CONSTANTS **18 hrs.**

Periodic array of atoms – fundamental types of lattices – index system for crystal planes – diffraction of waves by crystals – Brillouin zones – analysis of elastic strain – elastic compliance and stiffness constants – elastic waves in cubic crystals, quasi crystals and liquid crystals.

UNIT II: PHONONS: VIBRATIONS AND THERMAL PROPERTIES **18 hrs.**

Vibrations of crystal with monoatomic basis – two atoms per primitive basis – quantization of elastic waves – phonon momentum – inelastic scattering by phonons – phonon heat capacity – anharmonic crystal interactions – thermal conductivity.

UNIT III: FREE ELECTRON FERMI GAS **18 hrs.**

Energy levels in one dimension – effect of temperature on Fermi-Dirac distribution – free electron gas in three dimensions – heat capacity of electron gas – electrical conductivity and Ohm's law – motion in magnetic fields – thermal conductivity of metals – nearly free electron model – Bloch functions – Bloch Theorem – Kronig- Penney model – wave equation of electron in a periodic potential.

UNIT IV: ENERGY BANDS AND SUPERCONDUCTIVITY **18 hrs.**

Calculation of energy bands – experimental survey of superconductivity – theoretical survey of superconductivity –thermodynamics of the superconducting transition – London equation – coherence length – BCS theory of superconductivity – BCS ground State – type II superconductors – single particle tunneling – dc Josephson effect – ac Josephson effect – high temperature superconductors and its applications.

UNIT V: FERROMAGNETISM, FERROELECTRICS, CRYSTAL DEFECTS AND DISLOCATIONS **18 hrs.**

Ferromagnetic order – Curie-Weiss law – magnons – ferrimagnetic order- curie temperature and susceptibility of ferrimagnets – antiferromagnetic order – structural phase transitions – ferroelectric crystals – displacive transitions – lattice vacancies – diffusion – shear strength of single crystals – slip – dislocations – burgers vectors – stress fields of dislocations – strength of alloys – dislocations and crystal growth.

TEXTBOOK(S):

Charles Kittel., (2013). *Introduction to Solid State Physics,* (8^{th} ed.), New Delhi: John Wiley. Print.

Relevant sections in chapters - 1,2,3,4,5,6,7,8,9,10,12,16,20,21.

Relevant sections in chapter 9 and sub-sections in calculation of Energy bands.

Relevant sections in chapter 12 and sub-sections in Ferromagnetic order, Curie-Weiss law-magnons, ferrimagnetic order-Curie temperature and susceptibility of ferrimagnets, antiferromagnetic order

Relevant sections in chapter 16 and sub-sections in Structural phase transitions, ferroelectric crystals, displacive transitions.

REFERENCE BOOK(S):

Giuseppe G. & Giuseppe P., (2012). *Solid State Physics,* UK: Academic Press. Print.

Kakani S. L. & Hemarajni C., (2005). *Solid State Physics,* New Delhi: Sultan Chand. Print.

Wahab M. A., (2006). *Solid State Physics Structure and Properties of Materials*, New Delhi: Narosa Publishing House. Print.

WEBLINK(S):

Scott Ramsay. (2014, Apr 15). *Working with Crystallographic Planes and Miller Indices* [Video file]. Retrieved from https://youtu.be/JS9ysbgr0BE. CC BY License.

UniServeScienceVIDEO. (2013, Feb 18). *70037 Superconductor Meissner Effect DEMO V0353H* [Video file]. Retrieved from https://youtu.be/5hN8g5Wg-3U. CC BY License.

PGP3501CM SOLID STATE PHYSICS	
Class: II M. Sc. Physics	**Semester:** III
Cognitive Level	K-2 Understand
	K-3 Apply
	K-5 Evaluate

MAPPING: COs consistency with PSOs

PGP3501CM SOLID STATE PHYSICS					
CO/PSO	**PSO**				
	1	**2**	**3**	**4**	**5**
CO1	3	3	3	1	2
CO2	3	3	3	1	2
CO3	3	3	2	1	3
CO4	3	3	2	3	3
CO5	3	3	2	2	3

Strongly correlated (3), Moderately correlated (2), Weakly correlated (1)

PGP3201EI RENEWABLE ENERGY SOURCES AND EMERGING TECHNOLOGIES

(THEORY)

COURSE OUTCOMES: **4 hrs./wk.**

On successful completion of the course, the student will be able to

CO1: identify conventional and renewable energy sources

CO2: explain the working of geothermal power plants

CO3: analyse various photovoltaic technologies

CO4: acquire in-depth knowledge in biomass energy

CO5: investigate fuel cells and its applications

COURSE CONTENT:

UNIT I: ENERGY RESOURCES AND THEIR UTILIZATION **12 hrs.**

Conservation and forms of energy –electric energy from conventional sources – thermal plant – power generation – gas turbine plant – nuclear power: fission & fusion – energy reserves in India – hydroelectric power potential – renewable energy sources – new technologies: hydrogen energy systems – fuel cells – biofuels.

UNIT II: GEOTHERMAL ENERGY **12 hrs.**

Generating electricity from geothermal resources – types of geothermal plants – counter measures in operation of power plants – power house equipment – cooling tower system – comparison of geothermal power plants with other plants – advantages and disadvantages of geothermal power plant.

UNIT III: SOLAR PHOTOVOLTAIC TECHNOLOGIES **12 hrs.**

Solar PV Technology: advantages and limitations – basics of technology – solar PV systems and their components – solar PV lantern – stand-alone PV system: home lighting and other usage – solar PV water pumping system– solar power plant using satellite–plastic solar cells with nanotechnology.

UNIT IV: BIO MASS **12 hrs.**

Biomass resources–biofuels–biogas – liquid fuel– biomass conversion technologies– bio chemical conversion – biogas plants– bio mass cogeneration– ethanol from biomass–biodiesel– biofuel petrol–future of biomass energy in India.

UNIT V: HYDROGEN ENERGY SYSTEM AND FUEL CELLS **12 hrs.**

Emergence of hydrogen – hydrogen production – fuel cells: principle operation of fuel cell – technical parameter of a fuel cell – fuel processor – hydrogen for fuel cells from renewable sources – fuel cell types – advantages of fuel cell power plants – fuel cell battery powered bus system – energy output of a fuel cell – efficiency and emf of a fuel cell.

TEXTBOOK(S):

Bhatia S. C. & Gupta R. K., (2018). *Text Book of Renewable Energy*, New Delhi: Woodhead Publishing India Private Limited. Print.

Unit: 2, Ch.: 13.1- 13.7, 13.9

Chetan Singh Solanki, (2012). *Renewable Energy Technologies: A Practical Guide for Beginners,* New Delhi: PHI Learning Private Limited. Print.

Unit: 3, Ch.: 3.1, 3.3 – 3.7

Kothari. D.P, Singal. K.C. & Rakesh Ranjan, (2012). *Renewable Energy Sources and Emerging Technologies*, (2nd ed.), New Delhi: PHI Learning Private Limited. Print.

Unit: 1, Ch.: 1.2 – 1.6, 1.8, 1.13

Unit: 4,12.2-12.4,12.6,12.7,12.8,12.11,12.15,12.16,12.17,12.18,12.20.

Unit: 5, Ch.: 13.2 – 13.5, 13.7 – 13.9, 13.12, 13.13, 14.1 – 14.3

REFERENCE BOOK(S):

Garg. H. P. & Prakash. J., (2009). *Solar Energy*: *Fundamentals and Applications*, (1st ed.), New Delhi: Tata Mc Graw-Hill Publishing Company Limited. Print.

Khan. B.H., (2013). *Non-Conventional Energy Resources*, (2nd ed.), Tata McGraw Hill Education Private Limited. Print.

Roy L. Nersesian, (2011). *Energy for the 21stCentury: A Comprehensive Guide to Conventional and Alternative Sources*, (2nd ed.), Chennai: Micro Print (P) Ltd. Print.

Tiwari. G.N., (2010). *Solar Energy: Fundamentals, Design, Modelling and Applications*, New Delhi: Narosa Publishing House Pvt. Ltd. Print.

WEBLINK(S):

edeos-digital education. (2012, November 10).*Animated Video about Renewable Energy and the Energy Transition* [Video file]. Retrieved fromhttps://www.oercommons.org/courses/animated-video-about-renewable-energy-and-the-energy-transition/view. CC BY-NC license.

Delft University of Technology (2018, July 28). *Solar Energy: Photovoltaic (PV) Systems*[Video file]. Retrieved fromhttps://ocw.tudelft.nl/course-lectures/2-1-3-types-of-pv-systems/.CC BY-NC-SA license.

<table>
<tr><th colspan="3">PGP3201EI RENEWABLE ENERGY SOURCES AND EMERGING TECHNOLOGIES</th></tr>
<tr><td colspan="2">Class: II M. Sc</td><td>Semester: III</td></tr>
<tr><td rowspan="3">Cognitive Level</td><td colspan="2">K – 1 Remember</td></tr>
<tr><td colspan="2">K – 2 Understand</td></tr>
<tr><td colspan="2">K - 4 Analyse</td></tr>
</table>

PGP4301CP GENERAL LAB II

(LAB)

COURSE OUTCOMES: **3 hrs./wk.**

On successful completion of the course, the student will be able to

CO1: identify the physics concepts behind various experiments

CO2: demonstrate the concepts involved in acoustics, optics and magnetism

CO3: measure the physical parameters with maximum accuracy

CO4: analyse the experimental data using analytical and graphical tools

CO5: interpret the results and prepare a technical report

COURSE CONTENT: **45 hrs.**

LIST OF EXPERIMENTS (Any 10 experiments)

1. Diffraction studies using laser beam
2. Hysteresis curve of ferroelectric materials
3. Michelson's interferometer
4. Birefringence of a uniaxial crystal
5. Optical spatial filtering
6. Polarization by reflection
7. Spectrophotometer- spectral characteristics
8. Fermi energy calculations
9. Study of transients using storage oscilloscope
10. Studies of ultrasonic diffraction in organic liquids
11. Experiment with optical fiber and digital communication trainer
12. Rydberg constant
13. Constant deviation spectrograph

REFERENCE BOOK(S):

Chattopadhyay, D., Rakshit, P.C. &Saha, B., (2005). *An Advanced course in Practical Physics*, (7th ed.), Kolkata: New Central Book Agency Pvt. Ltd. Print.

Gupta, S.L. & Kumar, V., (2010). *Practical Physics with Viva-Voce*, (27th ed.), India: Pragati Prakashan Publishers. Print.

WEBLINK(S):

C.Sorensen-Unruh. (2015, November 6). *Energy Calculations: Rydberg Equation Practice*. [Video file]. Retrieved from https://www.youtube.com/watch?v=LHtlFKX-SRc . CC BY License.

T.Vishwam. (2012, October 24). Michelson interferometer 01.[Video file]. Retrieved from

https://www.youtube.com/watch?v=IsIFKxLLVd0. CC BY License.

COs cognitive level and mapping with PSOs:

PGP4301CP GENERAL LAB II						
CO	**Cognitive Level**	**PSO**				
		1	**2**	**3**	**4**	**5**
CO1	K-1 Remember	3	3	1	3	3
CO2	K-2 Understand	3	3	1	2	3
CO3	K-5 Evaluate	3	3	2	1	3
CO4	K-4 Analyse	3	3	3	3	3
CO5	K-5 Evaluate	3	3	4	3	3

Strongly correlated (3), Moderately correlated (2), Weakly correlated (1)

PGP4401CM MODERN OPTICS

(THEORY)

COURSE OUTCOMES: **5 hrs./wk.**

On successful completion of the course, the student will be able to

CO1: explain the principles of ray and wave optics

CO2: employ Fourier transform method in optical systems

CO3: appraise the effects of polarization, reflection and refraction

CO4: classify and explain different types of lasers

CO5: acquire an introductory knowledge of non-linear optics

COURSE OUTLINE:

UNIT I: RAY AND WAVE OPTICS **15 hrs.**

Ray optics: postulates of ray optics – graded index optics – matrix optics – wave optics: postulates of wave optics – complex representation and Helmholtz equation – beam optics: Gaussian beam – complex amplitude – properties – beam quality.

UNIT II: FOURIER OPTICS **15 hrs.**

Propagation of light in free space: spatial harmonic functions and plane waves – transfer function of free space – impulse response function of free space – Huygens – Fresnel principle – optical Fourier transform: Fourier transform in the far field – Fourier transform using a lens – image formation: ray-optics of a single–lens imaging system – wave optics of a 4f imaging system.

UNIT III: POLARIZATION OPTICS **15 hrs.**

Polarization of light: polarization – matrix representation – reflection and refraction – optics and anisotropic media: refractive indexes – propagation along a principal axis – propagation in an arbitrary direction – dispersion relation, rays, wavefront and energy transport – double refraction – optical activity – magneto-optics.

UNIT IV: LASERS **15 hrs.**

Theory of laser amplification: gain and bandwidth – phase shift – amplifier pumping: rate equation – pumping schemes – theory of laser oscillation: optical amplification and feedback – condition for laser oscillation – characteristics of laser output: power – spectral distribution – common lasers: solid state laser – crystalline and glass hosts – dopant ions – laser-diode pumping – neodymium-doped yttrium aluminum garnet (nd:yag) – semiconductor laser – fiber lasers – ramanfiber lasers – gas lasers – dye lasers – pulsed laser: methods of pulsing lasers – q-switching – mode locking: properties of a mode-locked pulse train.

UNIT V: NONLINEAR OPTICS **15 hrs.**

Nonlinear optical media – second-order nonlinear optics: second-harmonic generation and rectification – electro-optic effect – three-wave mixing – phase matching and tuning curves – phase matching methods: angle tuning and temperature tuning of crystals – third-order nonlinear optics: third-harmonic generation and optical kerr effect – self-phase modulation, self-focusing and spatial solitons – Raman gain – four-wave mixing – optical phase conjugation.

TEXTBOOK(S):

Saleh, B.E.A. & Teich, M.C., (2007). *Fundamentals of Photonics*, (2nd ed), New Jersey: A John Wiley & Sons Inc. Publication. Print.

Chapters: 1.1, 1.3, 1.4 2.1, 2.2A, 2.3, 3.1A, B,C, 4.1A, B, C, D, 4.2A, B, 4.4A, B, 6.1A, B,6.2, 6.3A, B, C, D, E, 6.4A, B, 14.1A, B, 14.2A,B,15.1A, B, 15.2A, B, 15.3A, B, C ,15.4A, C, D, 21.1, 21.2A, B, C, D, 21.3A, B, D, E.

Silfvast, W. T., (2003). *Laser Fundamentals*, (2nd ed.), Cambridge: Cambridge University Press. Print.

Chapters: 16.6, 15.3.

REFERENCE BOOK(S):

Jenkins, F. A. & White, H. E., (2011). *Fundamental of Optics*, (4th ed.), New Delhi: Tata Mc Graw-Hill Pvt. Ltd. Print.

Raj Pal, S. & Sirohi, (2003). *Wave Optics and its Application*, Hyderabad: Orient Longman Limited. Print.

Jerome, M. V. & Newell, A. C., (2008). *Nonlinear Optics*, New Delhi: Overseas Press. Print.

Ghatak, A., (2007). *Optics*, (3rd ed), New Delhi: The McGraw-Hill Companies. Print.

WEBLINK(S):

Herimanda, A. R. (2018) Geometrical Optics and Physical Optics. Retrieved fromhttps://oer.avu.org/bitstream/handle/123456789/794/PHY%2011_EN%20Geometrical%20 Optics%20Optics%20and%20Physical%20.pdf?sequence=1&isAllowed=yCC BY 4.0 license

SándorVarró, (2012). *Free Electron Lasers.* Retrieved from http://www.issp.ac.ru/ebooks/books/open/Free_Electron_Lasers.pdfCC BY 3.0 license.

COs cognitive level and mapping with PSOs:

PGP4401CM MODERN OPTICS						
CO	**Cognitive Level**	**PSO**				
		1	**2**	**3**	**4**	**5**
CO1	K-2 Understand	3	3	3	2	2
CO2	K-3 Apply	3	3	3	3	3
CO3	K-5 Evaluate	3	3	3	2	3
CO4	K-2 Understand	3	3	1	1	2
CO5	K-1 Remember	3	3	2	1	2

Strongly correlated (3) Moderately correlated (2) Weakly correlated (1)

PGP4401MO MATERIALS PHYSICS

(THEORY)

COURSE OUTCOMES: **5 hrs./wk.**

On successful completion of the course, the student will be able to

CO1: classify different types of materials

CO2: apply suitable techniques to characterize materials

CO3: explain phase transformations in materials

CO4: describe the mechanical, thermal and optical properties of materials

CO5: inquire about a few advanced materials

COURSE CONTENT:

UNIT I: CLASSIFICATION OF MATERIALS **15 hrs.**

Metals – Polymers: polymerization mechanism – degree of polymerization – classification – structure – applications – ceramics: classification – structure – properties – applications – composites: classification – particle reinforced composites – fibre reinforced composites – applications.

UNIT II: CHARACTERISATION OF MATERIALS **15 hrs.**

X-ray diffraction (XRD) – electron microscope – scanning electron microscope (SEM) – transmission electron microscope (TEM) – scanning transmission electron microscope (STEM) - micro and nano hardness test – atomic force microscope.

UNIT III: PHASE TRANSFORMATION IN MATERIALS 15 hrs.

Types of phase transformation: diffusion dependent and diffusionless – mechanism of phase transformation - kinetics of solid state reactions - homogeneous and heterogeneous nucleation – nucleation and growth – multiphase transformations - applications of phase transformations: dendrite formation – casting – amorphous structures – Iron-Carbon systems.

UNIT IV: MATERIALS PROPERTIES 15 hrs.

Mechanical properties: tensile strength – hardness – impact strength – factors affecting mechanical properties – thermal properties: thermal expansion and conductivity of materials – thermal stress – thermal fatigue – thermal shock – optical properties: interaction of light with solids, atoms and electrons – optical properties of metals and non-metals.

UNIT V: ADVANCED MATERIALS 15 hrs.

Biomaterials – smart materials – nanostructured materials – quantum dots – spintronics – fermionic condensate matter – shape memory alloys: properties – processing techniques – characterization techniques – liquid crystals

TEXTBOOK(S):

Kakani, S. L. & Amith Kakani, (2004). *Material Science,* New Delhi : New Age International (p) Limited.

Ch. 1.3, 1.5, 1.6, 1.7(C) -1.7(G), Ch.3.24,Ch.8.2 (Pg.216-217), 8.5(Pg. 228-230), 8.6, Ch. 9.16-9.19

Rajendran, V., (2012). *Materials Science*, New Delhi: Tata McGraw Hill Education Private Limited. Print.

Ch. 3.4, 3.9-3.18, 12.3, 12.4, 12.6, 12.7, 13.2.2, 13.2.3, 13.4, 21.1-21.4, 21.6, 22.1 - 22.3, 22.6, 22.7, 23.1 - 23.5, 23.8, 27.4 - 27.6

REFERENCE BOOK(S):

Pradeep, T., (2008). *Nano:The Essentials Understanding Nanoscience and Nanotechnology,* New Delhi: Tata McGraw Hill Education Private Limited. Print.

Narula, G. K., Narula, K. S. & Gupta, V. K, (2011). *Material Science*, New Delhi: Tata McGraw Hill Education Private Limited. Print.

Vijaya, M. S. & Rangarajan, G., (2012). *Material Science*, New Delhi: Tata McGraw Hill Education Private Limited. Print.

OER LINK(S):

nptelhrd. (2016, May 2). *Introduction to Scanning Electron Microscopy* [Video file], Retrieved from https://www.youtube.com/watch?v=mC0rYNlMz9Q. CC BY license.

Wutaz Kettlepot. (2019, August 26). *Primer on Mechanical Properties of Materials* [Video file], Retrieved from https://www.youtube.com/watch?v=6kcYqzeZYs0. CC BY license.

COs cognitive level and mapping with PSOs:

PGP4401MO MATERIALS PHYSICS						
CO	**Cognitive Level**	**PSO**				
		1	2	3	4	5
CO1	K-2 Understand	3	1	1	3	2
CO2	K-3 Apply	3	3	1	3	2
CO3	K-2 Understand	3	3	3	3	2
CO4	K-2 Understand	3	2	1	3	2
CO5	K-4 Analyse	3	1	1	3	2

Strongly correlated (3), Moderately correlated (2), Weakly correlated (1)

PGP4402CM NUCLEAR PHYSICS

(THEORY)

COURSE OUTCOMES: **5 hrs./wk.**

On successful completion of the course, the student will be able to

CO1: describe the structure and properties of nucleus

CO2: relate the types of decays and its applications

CO3: illustrate the conservation laws and particle's interaction by classifying the elementary particles

CO4: explain the interaction of radiation with matter in detectors

CO5: discuss the applications of radionuclides in industries and medical field

COURSE CONTENT:

UNIT I: NUCLEAR PROPERTIES AND STRUCTURE **15 hrs.**

Basic facts and definitions – Binding energy–The nuclear force – semi – empirical mass formula –Nuclear shell model: evidence for shell structure – independent particle motion and the shell model – the spin – orbit potential – Collective states – vibration and rotational states

UNIT II: NUCLEAR FISSION, FUSION AND INSTABILITY **15 hrs.**

Gamma emission : general features and selection rules – transition rate – internal conversion – Beta Decay: Beta–particle energy spectrum – allowed transition – forbidden transition – comparison of β–decay rates – electron capture – Alpha decay : semi–classical theory of α decay – alpha particle energies and selection rules – transuranic nuclei.– Characteristics of fission: fission and fission products – fission energy budget – delayed neutrons – neutron interactions – breeder reactions – The chain reaction in a thermal fission reactor: a nuclear power plant – the neutron cycle in a thermal reactor – moderators–Thermonuclear reaction and energy production: Basic reactions and Q value –cross section – fusion in the early universe – stellar burning

UNIT III: NUCLEAR REACTIONS AND ELEMENTARY PARTICLES **15 hrs.**

Direct reactions: angular momentum transfer in direct reactions – selectivity in direct reactions – Compound nucleus reactions: resonance in a compound nuclear reaction – low – energy, neutron–induced fission – Heavy ion reactions – classification of elementary particles – particle interactions–conservation laws – quark hypothesis of elementary particles – weak interaction

UNIT IV: DETECTORS AND INSTRUMENTATION **15 hrs.**

Gas detectors: ionization chamber – proportional counter – Geiger–Muller counter – Scintillation detectors – Semiconductor detectors: the p–n junction detector – the intrinsic detector – Neutron detectors: slow–neutron detection – fast–neutron detection– accelerators: ac and dc machines.

UNIT V: INDUSTRIAL AND MEDICAL APPLICATIONS **15 hrs.**

Industrial uses: tracing – gauging – material modification – sterilization – food preservation – other applications –Projection imaging: X –Radiography and the gamma camera –computed Tomography–Positron emission Tomography–Magnetic Resonance Imaging: Principles of MRI–excitation of a selected region–read out and MRI image formation–time variation of the signal–functional MRI –Radiation therapy: photons and electrons–radionuclides–neutron therapy–heavy charged particles

TEXTBOOK(S):

Ghoshal, S.N., (2008). *Nuclear Physics*, (1st ed.), New Delhi: S.Chand& Company Ltd. Print.

Chapters:18.16,18.20

Lilley, J.S., (2001). *Nuclear Physics Principles and Applications*, New Delhi: John Wiley & Sons, Ltd. Print.

Chapters: 1.3, 2.2.1,2.2.2, 2.3.1–2.3.3, 2.5.1,2.5.3, ch:3, 10.2, 10.3.1–10.3.3, 11.2, 11.5, 11.6, 4.4–4.6, 6.1–6.4, 6.6, 6.8, 8.1,8.2, ch:9

Tayal, D.C., (2013). *Nuclear Physics*, (1st ed.), Mumbai: Himalaya Publishing House. Print.

Chapters: 16.2,16.3,16.4

REFERENCE BOOK(S):

Heyde, K., (2010). *Basic Ideas and Concepts in Nuclear Physics*, (3rd ed.), Bristol and Philadelphia: Institute of Physics Publishing. Print.

Patel, S.B., (2012). *Nuclear Physics an Introduction*, (2nd ed.), New Delhi: New Age International Publishers. Print.

Wong, S.S.M., (2002). *Introductory Nuclear Physics*, New Delhi: Prentice Hall of India Private Ltd. Print.

Sanjiv,Puri, (2004).*Modern Physics Concepts and Applications,* New Delhi: Narosa Publishing House. Print.

WEBLINK(S):

Kieran Maher. (2016). *Basic Physics of Nuclear Medicine*. Retrieved from https://www.oercommons.org/courses/basic-physics-of-nuclear-medicine/view. CC BY-SA 4.0 License.

Kim Dirks, Manjula Sharma, Paul Peter Urone, Roger Hinrichs. (2017). *College Physics*. Retrieved from https://www.oercommons.org/courses/college-physics/view. CC BY- 4.0 License.

COs cognitive level and mapping with PSOs:

PGP4402CM NUCLEAR PHYSICS						
CO	**Cognitive Level**	**PSO**				
		1	**2**	**3**	**4**	**5**
CO1	K-2 Understand	3	2	1	2	1
CO2	K-1 Remember	3	2	1	2	2
CO3	K-2 Understand	3	3	1	2	2
CO4	K-5 Evaluate	3	3	2	3	3
CO5	K-6 Create	3	1	1	3	2

Strongly correlated (3), Moderately correlated (2), Weakly correlated (1)

PGP4501CM ATOMIC AND MOLECULAR SPECTROSCOPY

(THEORY)

COURSE OUTCOMES: **5 hrs./wk.**

On successful completion of the course, the student will be able to

CO1: recognize the interactions of electromagnetic radiation with matter

CO2: relate group theory to molecular vibrations and interpret the rotational spectra of molecules

CO3: analyse the vibrational spectra of polyatomic molecules

CO4: inquire the principles of Raman spectroscopy and SERS

CO5: interpret electronic and NMR spectra

COURSE CONTENT:

UNITI: ELECTRONIC SPECTROSCOPY OF ATOMS **15 hrs.**

Structure of atoms – electronic angular momentum – many electron atoms: the building-up (Aufbau) principle – spectrum of lithium and other hydrogen like species – angular momentum of many-electron atoms – term symbols – spectrum of helium and the alkaline earths – equivalent and nonequivalent electrons – photoelectron spectroscopy – Zeeman effect – stark effect – influence of nuclear spin.

UNITII: MOLECULAR SYMMETRY AND MICROWAVE SPECTROSCOPY **15 hrs.**

Symmetry operations – symmetry elements – algebra of symmetry operations – multiplication table – molecular point groups – matrix representation of symmetry operations – reducible and irreducible representations – great orthogonality theorem – character table for C_{2v} and C_{3v} point group – symmetry species of point groups – complete character table for point groups – rotation of molecules – rotational spectra – diatomic molecule – polyatomic molecules – chemical analysis by microwave spectroscopy.

UNITIII: INFRARED SPECTROSCOPY **15 hrs.**

Vibrating diatomic molecule – diatomic vibrating rotator – vibration-rotation spectrum of carbon monoxide – breakdown of Born-Oppenheimer approximation: interaction of rotations and vibrations – vibrations of polyatomic molecules – influence of rotation on the spectra of polyatomic molecules – analysis by infra-red techniques – applications.

UNITIV: RAMAN SPECTROSCOPY **15 hrs.**

Classical theory of Raman effect – pure rotational Raman spectra: linear molecules – symmetric top molecules – asymmetric top molecules – vibrational Raman spectra: Raman activity of vibrations – rule of mutual exclusion – vibrational Raman spectra – rotational fine structure –

structure determination from Raman and IR spectroscopy – effect of nuclear spin on Raman spectroscopy – resonance Raman scattering – stimulated Raman scattering – surface enhanced Raman scattering: surfaces for SERS study – enhancement mechanisms – surface selection rules – representative spectra – SERS microprobe – applications of SERS.

UNITV: ELECTRONIC AND SPIN RESONANCE SPECTROSCOPY 15 hrs.

Electronic spectra of diatomic molecules: Born– Oppenheimer approximation – vibrational coarse structure – Franck-Condon principle – Jablonski diagram – dissociation energy and dissociation products – rotational fine structure of electronic-vibrational transitions – fortrat diagram – predissociation – nuclear magnetic resonance: magnetic properties of nuclei – resonance condition – NMR instrumentation – dipolar interaction – chemical shift – indirect spin-spin interaction – interpretation of certain NMR spectra.

TEXTBOOK(S):

Aruldhas, G., (2009). *Molecular Structure and Spectroscopy*, (2nd ed.), New Delhi: Prentice Hall of India Pvt Ltd., Print.

Chapters: 3.16, 5.1–5.11, 10.1–10.3, 10.7–10.9, 10.20, 14.1–14.7, 8.16,15.6

Banwell, C.N., (2007). *Fundamentals of Molecular Spectroscopy*, (4th ed.), New Delhi: Tata McGraw Hill, Print.

Chapters: 2.1 – 2.4, 2.6, 3.1 – 3.7, 4.1 – 4.3,4.5, 5.1– 5.8, 6.1

REFERENCE BOOK(S):

Pavis, D.L., Lampman, G. M.,. Kriz, G. S. & Vyvyan, J. R., (2006). *Introduction to Spectroscopy,* (5th ed.), New Delhi: Cengage Learning India Pvt Limited. Print.

Gupta S. L., Kumar V. & Sharma R. C., (2006). *Elements of Spectroscopy,* (1st ed.), Meerut: Pragati Prakashan. Print.

Ferraro, J. R., Nakamoto, K. & Brown, C. W., (2005). *Introduction to Raman Spectroscopy,* (2nd ed.), New Delhi: Elsevier India Pvt Ltd. Print.

Pauling, L., (2001). *The Nature of Chemical Bond and the Structure of Molecules and Crystals*, Singapore: World Scientific Publishing Company, Pvt., Ltd. Print.

WEBLINK(S):

NPTELIIT Bombay. (2018). Week 1-Lecture 2 Steady State Spectra. [Video file]. Retrieved from https://www.youtube.com/watch?v=Lr8-mkmZBRQ. CC BY License.

NPTEL IIT Bombay. (2018). Lecture 33 : Infrared Spectra and Raman Spectra. [Video file]. Retrieved from https://www.youtube.com/watch?v=Yv8B5Czy7ZE. CC BY License.

NPTELIIT Bombay. (2018). Lecture 19 : Great Orthogonality Theorem and Character Table – I. [Video file]. Retrieved from https://youtu.be/txJE99xU5lA. CC BY License.

COs cognitive level and mapping with PSOs:

PGP4501CM ATOMIC AND MOLECULAR SPECTROSCOPY						
CO	**Cognitive Level**	**PSO**				
		1	**2**	**3**	**4**	**5**
CO1	K-2 Understand	3	2	1	2	2
CO2	K-2 Understand	3	2	2	2	3
CO3	K-4 Analyse	3	2	2	2	3
CO4	K-4 Analyse	3	2	2	2	3
CO5	K-3 Apply	3	2	2	2	2

Strongly correlated (3), Moderately correlated (2), Weakly correlated (1)