THE AMERICAN COLLEGE
POST GRADUATE DEPARTMENT OF PHYSICS
Programme for M. Sc. PHYSICS (w. e. f. 2018-19 onwards)

Semester	Course No.	Course Title	Hours/Wk	Credits	Marks
I	PGP / PSP 4431	Classical & Non Linear Dynamics	5	4	80
	PGP / PSP 4433	Mathematical Physics – I	4	4	80
	PGP / PSP 4435	Condensed Matter Physics – I	4	4	80
	PGP / PSP 4337	Astrophysics	4	3	60
	PGP / PSP 4339 Observational Astronomy PGP / PSP 4341 Physics of Home Appliances*		4	3	60
	PGP / PSP4343	Physics Lab – I	9	3	60
			30	**21**	**420**
II	PGP / PSP 4434	Instrumentation & Microcontrollers	5	4	80
	PGP / PSP 4436	Mathematical Physics – II	4	4	80
	PGP / PSP 4438	Quantum Mechanics – I	4	4	80
	PGP / PSP 4340	Nanophysics	4	3	60
	PGP / PSP 4342 Physics in Human Physiology PGP / PSP 4344 Sustainable Energy Resources*		4	3	60
	PGP / PSP 4346	Physics Lab – II	9	3	60
			30	**21**	**420**
III	PGP / PSP 5431	Nuclear & Particle Physics	5	4	80
	PGP / PSP 5433	Electrodynamics & Plasma Physics	4	4	80
	PGP / PSP 5435	Physical Electronics	4	4	80
	PGP / PSP 5437	Laser & Spectroscopy	4	4	80
	PGP / PSP 5439	Quantum Mechanics – II	4	4	80
	PGP / PSP 5441	Project – I	9	4	80
			30	**24**	**480**
IV	PGP / PSP 5432	Thin Films &Vacuum Technology	5	4	80
	PGP / PSP 5434	Condensed Matter Physics – II	4	4	80
	PGP / PSP 5436	Analog Electronics	4	4	80
	PGP / PSP 5438	Thermodynamics & Statistical Physics	4	4	80
	PGP / PSP 5440	Matrix, Fourier & Non Linear Optics	4	4	80
	PGP / PSP 5442	Project – II	9	4	80
			30	**24**	**480**

Programme Specific Outcome

On completion of the programme, postgraduates will be able to

PSO1 : Interpret fundamental interactions at quantum to astronomical scales;

PSO2 : Demonstrate a coherent understanding of the academic field of Physics, and its linkage with related disciplinary subjects;

PSO3 : Develop experimental and data analysis skills through a wide range of advanced level physics experiments;

PSO4 : Demonstrate the ability to use Physics skills such as formulating, identifying, and applying appropriate methodologies to solve and interpret a wide range of problems associated with Physics;

PSO5 : Design and execute mini projects to experience the aspects of research and to provide lucid summation of the scientific literature on a chosen topic;

PSO6 : Analyse and interpret data collected using appropriate methods, including the use of suitable software and customized worksheets, and relating the conclusions to relevant theories of Physics;

PSO7 :Demonstrate professional behaviour such as (i) being objective, unbiased and truthful in all aspects of work; and (ii) appreciation of intellectual property, environmental and sustainability issues;

PSO8 : Develop communication skills, both written and oral, for specialized and non-specialized audience;

PSO9 : Acquire subject knowledge and skills of the calibre sought by industry, professional career and public service, as well as providing academic teachers and researchers of the future;

PSO10: Demonstrate relevant generic skills and global competencies such as (i) skills of independent investigation of physics-related issues and problems; (ii)ability to construct logical arguments using correct technical language related to physics.

PSO to PO Mapping for PG Physics

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
PSO1	X	X		X		X	X		X	
PSO2	X	X		X		X	X		X	
PSO3	X	X		X	X	X	X		X	
PSO4	X	X	X	X	X			X		
PSO5	X	X	X		X	X			X	
PSO6	X	X	X	X	X			X		
PSO7	X		X		X	X	X	X		
PSO8	X		X	X		X	X		X	
PSO9	X	X		X		X		X	X	
PSO10	X		X		X	X			X	X

Mapping of Courses with Programme Specific Outcomes (PSOs)

Courses	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PSO 9	PSO 10
PGP/PSP 4431	X	X		X			X		X	X
PGP/PSP 4433	X	X		X			X		X	X
PGP/PSP 4435	X	X		X			X		X	X
PGP/PSP 4337	X	X		X			X		X	X
PGP/PSP 4339	X	X					X		X	X
PGP/PSP 4341	X	X					X		X	X
PGP/PSP 4343	X	X	X	X		X	X		X	
PGP/PSP 4434	X	X		X			X		X	X
PGP/PSP 4436	X	X		X			X		X	
PGP/PSP 4438	X	X		X			X		X	X
PGP/PSP 4340	X	X		X			X		X	
PGP/PSP 4342	X	X					X		X	X
PGP/PSP 4344	X	X				X	X		X	
PGP/PSP 4346	X	X	X	X			X		X	
PGP/PSP 5431	X	X		X			X		X	X
PGP/PSP 5433	X	X		X			X		X	X
PGP/PSP 5435	X	X		X			X		X	X
PGP/PSP 5437	X	X		X			X		X	X
PGP/PSP 5439	X	X		X			X		X	X
PGP/PSP 5441	X	X		X	X	X	X	X	X	
PGP/PSP 5432	X	X		X			X		X	X
PGP/PSP 5434	X	X		X			X		X	X
PGP/PSP 5436	X	X		X			X		X	X
PGP/PSP 5438	X	X		X			X		X	X
PGP/PSP 5440	X	X		X			X		X	X
PGP/PSP 5442	X	X		X	X	X	X	X	X	

PGP/PSP 4431 **CLASSICAL AND NON-LINEAR DYNAMICS** **5 hrs / 4Cr**

This course is designed to introduce to the students, the basic concepts and application of Lagrangian dynamics, Hamiltonian dynamics, small oscillations, rigid body systems and nonlinear dynamics

At the end of thecourse, students will be able to

i. construct Lagrangian for holonomic systems and analyze its behaviour using Lagrangian dynamics
ii. analyze central force problems and find the normal modes of vibration of oscillating bodies
iii. form inertia matrix and solve rigid body problems using Euler's equation of motion
iv. analyze the system using Hamiltonian dynamics and Poisson brackets
v. find the equilibrium points and classify the non-linear systems in to major bifurcations

Unit I: Lagrangian Dynamics
Constraints - D' Alembert's Principle and Lagrange's Equations - Velocity-Dependent Potentials and the Dissipation Function - Hamilton's Principle - Some Techniques of the Calculus of Variations - Derivation of Lagrange's Equations from Hamilton's Principle - Conservation Theorems and Symmetry Properties - Energy Function and the Conservation of Energy.

Unit II: Central Force Problem and Small Oscillations
Reduction to the Equivalent One-Body Problem - The Equations of Motion and First Integrals - Scattering in a Central Force Field - Transformation of the Scattering Problem to Laboratory Coordinates-Small Oscillations- The Eigenvalue Equation and the Principal Axis Transformation- Frequencies of Free Vibration, and Normal Coordinates, Linear Tri atomic Molecule.

Unit III: Rigid body Dynamics
The Independent coordinates of a Rigid Body - Orthogonal Transformations - The Euler Angles - Angular Momentum and Kinetic Energy of Motion about a Point – Tensors - the Inertia Tensor and the Moment ofInertia - The Eigenvalues of the Inertia Tensor and the Principal Axis Transformation - Solving Rigid Body Problems and the Euler Equations of Motion.

Unit IV: Hamiltonian dynamics and Canonical Transformations
Legendre Transformations and the Hamilton Equations of Motion - Cyclic Coordinates and Conservation Theorems - Equations of Canonical Transformation - Examples of Canonical Transformations - The Harmonic Oscillator - The Symplectic Approach to Canonical Transformations - Poisson Brackets and Other Canonical Invariants - The Angular Momentum Poisson Bracket Relations.

Unit V: Nonlinear dynamics

Autonomous and non - autonomous systems – Differential equation: equilibrium points-Phase space and Phase trajectories - Stability, Attractors and Repellers - General criteria forstability– Classification of Equilibrium Points - Periodic Attractor - Some simple bifurcations - Saddle-Node, Pitchfork, Transcritical and Hopf.

Text Books:

1. Goldstein, Poole and Safko, *Classical Mechanics*, 3 edition, Pearson Publication (2001)

2. M. Lakshmanan and S. Rajasekar, *Nonlinear Dynamics*, Springer (India) Pvt. Ltd. (2003)

References:

1. John R. Taylor, *Classical Mechanics*, University Science Books, (2004)
2. Louis N. Hand and Janet D. Finch, *Analytical mechanics*, Cambridge University Press, (1998)
3. J.C. Upadyaya, *Classical Mechanics*, Himalayan Publishing House, New Delhi (2009)

Bloom's Taxonomy	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
K1: Remembering	1				
K2: Understanding	2		2	2	
K3: Applying	3		3		
K4: Analyzing				4	4
K5: Evaluating		5			5
K6: Creating					
Mean					3.10

PGP/PSP 4433 **MATHEMATICAL PHYSICS - I** **4 hrs / 4 Cr**

This course helps to understand the complex variables and acquire knowledge about special functions and series solutions of differential equations in physics. Students get basic concept about Fourier series and integral transforms also familiarizing withnumerical methods and to impart mathematical knowledge for the description of physics phenomena

At the end of the course, students will be able to

i. explain the characteristics of complex functions, evaluate residues and definite integrals.
ii. describe the properties and usage of special functions in physics
iii. elucidate the characteristics of orthogonal polynomials

iv. expand the periodic functions using Fourier series and apply integral transforms
v. solve polynomials, integral and differential equations using numerical methods.

Unit I: Complex Variable

Functions of a complex variable – analytic function – Cauchy-Riemann conditions - Cauchy's integral theorem and integral formula - Taylor's and Laurent's expansions - Cauchy residue theorem – Evaluation of residues - Evaluation of definite integrals

Unit II: Special Functions in Physics

Gamma functions – Beta functions – Dirac-Delta functions – Green's functions- One dimension – Two and three dimension - Applications of Green's functions.

Unit III: Series Solutions of Differential Equations in Physics

Differential equations, Generating function, Rodrigues' formula Recurrence relations and Orthogonality of Bessel, Legendre, Hermite and Laguerre polynomials

Unit IV: Fourier series and Integral Transforms

Fourier series - Application of Fourier series - Fourier Integral theorem - Fourier Transform – Convolution theorem – Parseval's relation – Transforms of derivatives - Application of Fourier transform - Laplace transform - Application of Laplace transform.

Unit V: Numerical Methods

Roots of polynomial and transcendental equations - Newton-Raphson method - Lagrange's interpolation - Numerical integration - Trapezoidal, Simpson's method - Euler's method, Runge-Kutta method

Text Books:

1. Charlie Harper, *Introduction to Mathematical Physics*, Prentice-Hall, Inc, (2008)
2. George B. Arfken and Hans J. Weber, *Mathematical Methods for Physicists*, Elsevier Academic Press Seventh Edition, (2012)
3. M.K. Venkataraman, *Numerical Methods in Science and Engineering*, National Publishing Co, Fifth Edition, (1999)

References:

1. Eugene Butkov, *Mathematical Physics*, Addison Wesley Publishing Company (1995).
2. Louis A. Pipes and Lawrence R. Harvill,*Applied Mathematics for Engineers and Physicists*, McGraw-Hill, International Third Edition (1970).
3. Sadri Hassani, *Mathematical Physics. A Modern Introduction to its Foundations*, Springer Second Edition (2002).
4. Mary L Boas, *Mathematical Methods in the Physical Sciences*, John Wiley & Sons Third Edition (2005).
5. P.K.Chattopadhyay, *Mathematical Physics*, New Age International Publishers (2013).

Bloom's Taxonomy	CO1	CO2	CO3	CO4	CO5
K1: Remembering		1			
K2: Understanding	2				
K3: Applying		3			3
K4: Analyzing	4		4	4	
K5: Evaluating				5	5
K6: Creating					
Mean					3.44

PGP/PSP 4435 **CONDENSED MATTER PHYSICS – I** **4 hrs / 4 Cr**

This course exposes students to have a detailed discussion on different crystal structures, various diffraction techniques and different imperfection in crystals; it also deals with the different bonding natures in crystals. It also attempts to have a systematic approach to problem solving in crystal vibrations.

At the end of the course, students will be able to

i. determine the structure factors and atomic scattering factor of crystal lattices.
ii. describe the X-ray diffraction and anomalous dispersion to predict the crystal structure and temperature effects
iii. classify and differentiate the defects in crystals.
iv. explain and relate different crystal binding forces.
v. describe and examine the effect of lattice vibrations.

Unit I: Crystallography

Basic concepts of crystallography-Index system for crystal planes –Simple crystal structure – Reciprocal lattice vectors – Fourier analysis of the basis: Structure factor for SC, BCC, FCC structures – Atomic scattering factor- Quasi crystals.

Unit II: Crystal diffraction

Braggs law – different scattering methods-derivation of scattered wave amplitude -anomalous dispersion of scattering by crystals- Theory of X-ray diffraction-temperature effect- crystal structure determination

Unit III: Crystal imperfections

Imperfections in crystals –Point defects: Lattice vacancies- Diffusion- Colorcenters- Surface and interface physics: Concentration of Frenkel and Schottky defects – Line imperfections – Screw imperfection – Burger vector – Surface imperfections – volume defects-Dislocations.

Unit IV: Crystal binding

Crystals of inert gas – van der Walls interactions – Repulsive interaction – Equilibrium lattice constants – Cohesive energy – Ionic crystals – Madelung energy – Evaluation of Madelung constant – Covalent, Metallic and Hydrogen bonding – elastic strain components

Unit V: Crystal vibrations

Vibrations of crystal with monoatomic basis – group velocity – Two atoms per basis – Quantization of elastic waves – Phonon momentum – Phonon heat capacity – Debye theory of specific heat – Debye T^3 law – Anharmonic crystal interactions

Text Book:

1. Charles Kittel, *Introduction to Solid State Physics*, 5th edition, (1993).

References:

1. S.O. Pillai, *Solid State physics*, New age international (P) limited (1997).
2. Ali Omar, *Elementary Solid State Physics*, Pearson Education India, (2000).
3. H.V Keer, *Principles of Solid State*, Wiley Eastern Lmt. (1994)
4. M.A.Wahab, *Solid State Physics*, Narosa Publishing house, Delhi, (1999)

Bloom's Taxonomy	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
K1: Remembering	1				
K2: Understanding			2	2	2
K3: Applying			3		
K4: Analyzing		4			
K5: Evaluating	5			5	
K6: Creating					
Mean					3.0

PGP / PSP 4337 **ASTROPHYSICS** **4hrs/3Cr**

This course offers a comprehensive introduction to astronomy and astrophysics. The students are exposed to evolution of stars and mysterious objects. The models of universe and theories of cosmology are also intended.

At the end of the course, students will be able to

i. explainthe role of Copernicus, Kepler and Newton in the development of modern astronomy and specify the classification of stars and compute the magnitudes of stars.
ii. describe the working of various types of telescopes and outline the spectral analysis
iii. predict the structure of the sun, its layers and compile types of galaxies and various mysterious objects
iv. analyse the birth and death of stars using H-R diagram and quote the fate of the star using Chandrasekhar's mass limit.
v. ascertain the evolution of universe using different models

Unit I: Positional Astronomy

Development of Astronomy and Birth of Modern Astronomy – Physics of Kepler and Newton – Seasons – Time and Precession – Constellation and nomenclature of stars – Stellar distance – Stellar magnitude – Spectral Classification – Colour index – Aberration and Parallax.

Unit II: Astronomical Observations
Optical telescopes – Types of telescopes – Reflector and refractor type - Recording devices – Photography , Photomultipliers and CCDs. Radio telescope – Interferometers, T, Y and Cross interferometers. Techniques of observation in IR, UV, X – Ray and Gamma ray regions.

Unit III: Sun and Stellar Bodies
Sun as a star – layers of Sun – Photosphere – Chromosphere – Corona – phenomenon of Sun – sun spots – Prominences – solar flares – eclipses – Galaxy – Types of Galaxies – Milky way galaxy – Comets- Asteroids and meteoroids.

Unit IV: Stellar Structure and Evolution:
Basics equations of stellar structure – Nuclear energy sources – Jean's criterion - Star formation – H-R diagram – Main sequence stars – end state of stars – Chandrasekhar mass limit – white dwarfs – Novae and Super novae – Neutron star – Black hole – Binaries and Variable stars.

Unit V: Cosmology
Hubble's law – Models of Universe – The Big-Bang – Steady State theory – consequences of general theory of relativity – Bending of light – Background radiation – Future of the Universe.

Text Books:

1. George O. Abell, *Exploration of the Universe*, Saunders College Publishing, (1986)
2. K.D.Abhyankar, *Astrophysics – Stars and Galaxies*, Tata McGraw Hill Publications, (1989).
3. William Kaufmann, *Astronomy: The Structure of the Universe*, McMillan Publishing Co.inc, New York.(1999).

References:

1. R.Alder, M.Bazrin and M.Schiffer, *Introduction to General theory of Relativity*, McGraw Hill Publications, (1975)
2. Frank H. Shu, *The Physical Universe, An introduction to Astronomy*, University Science Books, Mill Valley, California, (1982)

Bloom's Taxonomy	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
K1: Remembering	1				
K2: Understanding		2			
K3: Applying			3		
K4: Analyzing				4	
K5: Evaluating		5			5
K6: Creating					3.33

PGP/PSP 4339 **OBSERVATIONAL ASTRONOMY** **4 hrs / 3 Cr**

This course intends to provide the knowledge on the birth of modern astronomy and views from astronomers. It provides an understanding about the evolution of stars. It also deals with the classification of galaxies.It enables the student to compare and to learn the working principle of different types of telescopes. In addition the course deals with the different theories of universe.

At the end of the course, students will be able to

i. summarise the birth of modern astronomy from ancient times
ii. describe the theory of birth and evolution of stars.
iii. categorize galaxies based on Hubble classification and distinguish various mysterious objects
iv. compare the different types of telescopes
v. explain different models of origin of universe

Unit I: Birth of Modern Astronomy

Birth of modern astronomy- –Compare and contrast the views of reality held by Plato and Aristotle– universe in the seventeenth century – Kepler's Laws – Newtonian gravitation – seasons – Eclipse – Solar, lunar - solar family.

Unit II: Stellar Evolution

Formation of a star from a cloud of interstellar matter- Birth of low mass stars like our sun, - main-sequence star to a dead star- white dwarf - neutron star - Inventory of the Solar System

Unit III Galactic astronomy:

Milky Way - Hubble classification of galaxies-Spiral galaxies, Elliptical galaxies,Irregular galaxies, Dwarf galaxies – Mysterious objects – Pulsar, Quasar, comets, asteroids - meteors and meteoroids.

Unit IV: Telescopes

Astronomical observations – optical telescopes – Reflecting – refracting – telescope mount – – Radio telescope –– UV-IR-X-ray telescopes.

Unit V: Origin of Universe

The Big bang - Formation of Elements, Discovery of the Galaxies, Expansion of the Universe – Hubble's law – steady state – pulsating theory

Text books:

1. Nigel Marshall, *GCSE Astronomy*, IV Edition , Mickledore Publishing, (2010)
2. William J. Kaufmann, *Astronomy: The Structure of the Universe*, Macmillan Publishers Co.,Inc. New York, (1999)

References:

1. Shu F, *The physical universe*, University of California, (1982).

2. George O.Abell, *Exploration of the Universe*, Saunders college publishing, (1986)
3. K.D.Abhayanker, *Astrophysics Stars and Galaxies*, Tata McGraw – Hill publishing, New Delhi (1992)

Bloom's Taxonomy	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
K1: Remembering	1				
K2: Understanding	2	2			2
K3: Applying			3		
K4: Analyzing				4	
K5: Evaluating		5		5	
K6: Creating					
Mean					3.0

PGP/PSP 4341 **PHYSICS OF HOME APPLIANCES** **4hrs / 3 Cr**

This course intends to provide an understanding on the basics of electricity and electronics. It enables the student to have a hands-on experience on the usage of multimeter and for soldering the basic components. It also deals with the working principle of different domestic appliances and provides knowledge for maintaining them.

At the end of the course, students will be able to

i. explain the fundamentals of electricity and electronic components.
ii. implement the skills of testing and servicing the basic equipment of the home appliances.
iii. classify different domestic appliances and explain the physics of appliances
iv. ascertain the maintenance of domestic appliances
v. explain the energy consumption of home appliances

Unit I: Introduction to Electricity and Electronics

Basic Electricity: Voltage, Current, Resistance, Impedance & Power factor -Transformers - Step-up & Step-down - Single phase & Three phase circuits – Fuse, Concept of Earthing

Electronics: Familiarization of electronic components - Capacitor, Choke coil, Diode, Transistor, Thyristor

Basic Equipments for testing and servicing: Multimeter - Measurement of current, voltage and resistance - Checking transistors and diodes in circuit measurements - Soldering Iron - Flux - Lead

Unit II: Heating Appliances

Electric stove - Electric Rice cooker - Toaster - Kettle - Coffee maker -Iron box -Immersion heater - Geyser - Hair drier- Microwave oven

Unit III: Motorised Appliances

Electric fans - Mixer - Grinder/Blenders –Washingmachine - Vacuum cleaner - Domestic water pump - Dish washer

Unit IV: Refrigeration Appliances

Refrigerator: Compressor - coolants - Automatic defrost circuits - Air coolers - Air conditioners

Unit V: Other Appliances

Lights: Incandescent Bulbs, Tubelight, CFL bulb – LED- Voltagestabilizer - Inverters – UPS

Text books:

1. B.L. Theraja& A.K. Theraja, *A Text Book of Electrical Technology*, S. Chand & Company Ltd., New Delhi, India, (2005)

References

1. Eric Kleinert, *Troubleshooting and Repairing major appliances*, McGraw Hill Professional, 3rd edition, (2012)
2. ShashiBhushanSinha*, Handbook of Repair and Maintenance Of Domestic Electronics Appliances*, BPB Publications, India, (2016)

Bloom's Taxonomy	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
K1: Remembering	1				
K2: Understanding	2		2	2	2
K3: Applying			3		
K4: Analyzing				4	
K5: Evaluating		5			
K6: Creating		6			6
Mean					3.33

PGP/PSP 4343 **PHYSICS LAB - I** **9 hrs / 3 Cr**

The laboratory sessions are designed toinculcate good laboratory practice and work habits. This is also a place to reinforce the concepts and techniques presented in the lectures. This course also teaches the students to get acquainted with data and error analysis and offers hands-on experience with moderninstrumentation and soft skills.

At the end of the course, students will be able to

i. practice systematic laboratory work habits;
ii. design experiments and verify theoretical concepts;
iii. perform Data and error analysis;
iv. handle advanced equipment in the lab;
v. troubleshoot physics experiments.

Total of 16 Experiments:
Compulsory experiments:

1. Fabrication of a dual power supply –regulation study
2. Familiarization of CRO, signal generators
3. Work shop practice – Use of tools and machines.

Any 7 from the following:

4. Familiarization - excel – calculations and graph and PCB software
5. CDS calibration – Na Lamp – Hg spectrum –FabryPerot etalon.
6. Michelson interferometer – Wavelength –Na, Hg & laser.
7. Reflection grating – finding groove spacing- CD, DVD and grating.
8. Calibration techniques - Thermister - Thermocouple
9. linear polarizer & Quarter wave plate - circular and elliptical polarization
10. Eddy current – Electromagnet & mapping the magnetic field.
11. Refractive index of glass, and liquids, sugar content– laser pointer.
12. Fourier series - analyzing periodic function - experiment
13. Balmer series - hydrogen spectrum – Rydberg constant
14. Hartman interpolation formulae – CDS
15. Age of universe - using spectrum and galaxy diagram
16. Channelled spectrum – to determine the thickness of mica sheet

Any 6 from the following:

17. Characteristics of a solar cell- fill factor.
18. Band Energy gap using diode and LED
19. Study of ac circuits – RC, RL, and LCR – using CRO.
20. Use of Digital and Analog Simulation software for solving circuits.
21. Lab View – Data logging
22. Study of charging and discharging of a capacitor.
23. OP-AMP - wave form generator- sine-square-triangle-ramp
24. second order active filter - OP-AMP
25. Timer 555 – a stable, mono stable, bi stable, VCO and Schmidt trigger.
26. Multiplexing and demultiplexing - 4- bit

Bloom's Taxonomy	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
K1: Remembering	1				
K2: Understanding		2			
K3: Applying			3	3	
K4: Analyzing			4		
K5: Evaluating					
K6: Creating					6
Mean					3.17

PGP / PSP 4434 INSTRUMENTATION & MICROCONTROLLERS 5 hrs/4Cr

This course enables the students to learn the fundamentals of system design and instrumentation and to study its characteristicsand applications. This course gives the fundamental knowledge of signal processing. This course also introduces the students to know the basics of microcontroller and to write simple programs.

At the end of the course, students will be able to

i. analyze the fundamentals of system design and instrumentation.
ii. elucidate the characteristics and applications of transducers
iii. explain the fundamentals of signal processing
iv. describe the architecture and the instruction sets of microcontroller
v. explain the different interfaces related to microcontroller

Unit I: Generalized Characteristics of Instruments & Error

Static characteristics: Accuracy – precision-repeatability – resolution – sensitivity – linear and non linear systems – drift – span – range - noise and filtering - loading effect- Dynamics characteristics: Transfer function – response of first and second order instruments to standard inputs - dead – time elements. Measurement- need for measuring errors in physics - types, measurement and propagation of errors- linear and non -linear curve fitting– least square fitting – Goodness of fit – chi squares fitting

Unit II:Transducers

Introduction – Classification of transducer – Potentiometer - linear measurement – strain gauge – thermistor – thermocouples –capacitive transducers – thermoelectric transducers – Piezo electric transducers - characteristics and applications.

Unit III: General measurements and signal processing

Pressure / vacuum transducers - Measurement of time and energy –Signal conditioning and recovery, impedance matching, amplification (Op-amp based, instrumentation amp, feedback), filtering and noise reduction, shielding and grounding; Fourier transforms; lock-in detector, box-car integrator.

Unit IV: Microcontroller:

PIC18FXX2 Microcontroller Introduction- Architecture- memory organization-registers-addressing modes-data transfer and control instructions-basic arithmetic instructions-logic instructions-assembly language programs-embedded C programs

Unit V: Operations and Applications

PIC18FXX2 Microcontroller I/o Operations and Applications - Interrupts- Timers- PWM – UART - I2C bus - SPI interface – USB - A/D Conversion - D/A Conversion - frequency measurement - temperature measurement - Stepper motor control.

Text Books:

1. A.K.Sawney, *Electrical and electronic measurements and instrumentation*, Dhanpat Roy and co, (2005)
2. Robert B. Reese, *Microprocessors from assembly language to C using PIC18FXX2*, Shroff publishers and distributors, (2005)

References:

1. Alan.S.Morris,*Principles of Measurement and Instrumentation*, Prentice Hall of India, New Delhi,(1999)
2. D.V.S.Murthy,*Transducers and Instruments* , Prentice Hall of India, New Delhi, (1995)
3. W.D.Cooper and A.D.Helfrick, *Electronic Instrumentation and Measurement Techniques,* Dorling Kindersly Pvt. Ltd. India (2009)
4. John B Peatman, *Embedded design with the PIC18F452 microcontroller*, Pearson Education Inc., (2003).
5. Smith D. *W, PIC n practice.A project based approach*, Elsevier, (2008).

Bloom's Taxonomy	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
K1: Remembering	1				
K2: Understanding	2		2		
K3: Applying		3			3
K4: Analyzing		4	4	4	
K5: Evaluating				5	
K6: Creating					
Mean					**3.11**

PGP / PSP 4436 **MATHEMATICAL PHYSICS - II** **4 hrs / 4 Cr**

This Course introduce linear vector, matrices, Tensors, probability and group theory by exploring mathematical behaviour in physics. Students familiarize themselves with the importance and uniqueness of mathematical tools to analyse physics phenomenon.

At the end of the course, students will be able to

i. explain the properties of linear vector space and matrices and apply them to analyze a broad range of physical models
ii. apply the concepts of Tensor analysis and Tensor calculus to formulate physical laws and simplify them using coordinate transformations
iii. apply probability and statistical laws to physical problems
iv. explain basic concepts in group theory and its importance in physics
v. usecharacter table and group symmetry to form irreducible representations

Unit I: Linear Vector Space and Matrix Analysis

Definition of a linear vector space – Linear independence, basis – Scalar product – Orthonormal basis – Gram-Schmidt orthogonalization process – Linear operators. Special matrices – Eigen values and Eigen vectors – Cayley Hamilton theorem – Coordinate transformations.

Unit II: Tensors Analysis
Introduction – Transformation of Coordinates – Contravariant and Covariant tensors - Algebra of tensors – Quotient law – The line element – Fundamental metric tensor – Associate tensors.

Unit III: Tensors Calculus and Probability
Christoffel symbols – Covariant differentiation of tensors – Equation of the Geodesic line – Riemann-Christoffel tensors. Elementary probability theorem – random variables – Binomial, Poisson and Normal distributions

Unit IV: Abstract Group Theory
Definition and nomenclature – multiplication table – Rearrangement theorem – Cycle groups – Sub-groups – Cosets, class – Normal divisors and factor groups – Class multiplication - Continuous groups – SU(2) and SU(3) – Orthogonal.

Unit V: Theory of Group Representation
Reducible and irreducible representation – Great orthogononality theorem (no proof) – Character representation – Character table decomposition of reducible representation – Regular representation – Application of representation theory

Text Books:

1. P.K.Chattopadhyay, *Mathematical Physics*, New Age International Publishers (2013).
2. Charlie Harper, *Introduction to Mathematical Physics*, Prentice-Hall, Inc (1976),
3. Louis A. Pipes and Lawrence R. Harvill,*Applied Mathematics for Engineers and Physicists*, McGraw-Hill, International Third Edition (1970)
4. A.W.Joshi, *Elements of group theory for physicists*, New Age International Publishers (1997),

References:

1. Eugene Butkov, *Mathematical Physics*, Addison Wesley Publishing Company (1995).
2. A.W.Joshi, *Matrices and Tensors in Physics*. New Age International Publishers (2017)**.**
3. George B. Arfken, Hans J. Weber and Frank E. Harris, *Mathematical Methods for Physicists*, Elsevier Academic Press Seventh Edition (2012).
4. Sadri Hassani, *Mathematical Physics. A Modern Introduction to its Foundations*, Springer Second Edition (2002).
5. Mary L Boas, *Mathematical Methods in the Physical Sciences*, John Wiley & Sons Third Edition (2005).
6. SathyaPrakash, *Mathematical Physics*, Sultan Chand and Sons (2014).

Bloom's Taxonomy	CO1	CO2	CO3	CO4	CO5
K1: Remembering	**1**				
K2: Understanding	**2**	**2**			
K3: Applying			**3**		**3**
K4: Analyzing			**4**	**4**	
K5: Evaluating		**5**			
K6: Creating					
Mean					3.0

PGP / PSP 4438 **QUANTUM MECHANICS - I** **4 hrs / 4 Cr**

This course deals with the basics of quantum mechanics, exactly solvable eigenvalue problems, theory of angular momentum, and scattering theory.

At the end of the course, students will be able to

i. describe and apply the concepts of quantum mechanics to exactly solvable systems
ii. explain the general formalism of wave mechanics.
iii. find the energy eigen functions and eigen values of bound state systems
iv. describe the theory of general angular momentum and its applications
v. elucidate the quantum theory of scattering in low energy and high energy approximations.

Unit I: The Schrodinger Equation and Stationary States

A Free particle in One Dimension – Generalization to Three Dimensions – The Operator Correspondence and the Schrodinger Equation for a Particle Subject to Forces – Normalization and Probability Interpretation – Non- normalizable Wave Functions and Box Normalization – Conservation of Probability – Expectation Values : Ehrenfest's Theorem – Admissibility Conditions on the Wave Function – A Particle in a Square Well Potential – Square Potential Barrier – Delta-Function Well

Unit II: General Formalism of Wave Mechanics

The Fundamental Postulates of Wave Mechanics – The Eigenvalue Problem: Degeneracy – Observables: Completeness and Normalization of Eigenfunctions – Closure – Physical Interpretation of Eigenvalues, Eigenfunctions and Expansion Coefficients – The Uncertainty Principle – States with Minimum Value for Uncertainty Product – Commuting Observables: Removable Degeneracy.

Unit III: Exactly Solvable Eigenvalue Problems

The Simple Harmonic Oscillator – Analytical Method – The Abstract Operator Method – Angular Momentum and Parity – Eigenvalue Equation for L^2: Eigenvalues and

Eigenfunctions – Spherical Harmonics – The Hydrogen Atom – Solutions of the Radial Equation: Energy levels – Stationary State Wave functions - Charged particle in a uniform magnetic field – Integer Quantum Hall Effect.

Unit IV: Angular Momentum

The Hilbert Space of State Vectors: Dirac notation – Representation of Dynamical Operators – Unitary Transformation - The Eigenvalue Spectrum – Matrix representation – Spin Angular Momentum – A Charged particle in a uniform magnetic field - Non-relativistic Hamiltonian with Spin : Diamagnetism – Addition of Angular momenta – Evaluation of C. G. Coefficients - Spin Wave functions for a system of two spin-1/2 particles - Identical Particles with Spin.

Unit V: Scattering Theory

Kinematics of the Scattering Process – Wave Mechanical Picture of Scattering – Green's functions: Formal Expression for Scattering Amplitude – The Born Approximation; Partial Wave Analysis – Phase Shifts – The Scattering Amplitude in terms of Phase shifts – The Differential and Total Cross-Section: Optical Theorem – Phase shifts: Relation to Potentials – – Scattering by a Square Well, Hard Sphere;

Text Book:

1. P. M. Mathews & K. Venkatesan, *A Text Book of Quantum Mechanics*, 2^{nd} Ed., Tata McGraw Hill, New Delhi (2013)

References:

1. L. I. Schiff, *Quantum Mechanics*, 3^{rd} Ed., McGraw Hill New York (1968).
2. G. Aruldhas, *Quantum Mechanics*, 2^{nd} Ed., PHI Learning Private limited, New Delhi (2013).
3. J. J. Sakurai, *Modern Quantum Mechanics*, Addition-Wisley (1999).
4. S. R. Shankar, *Principles of Quantum Mechanics*, 2^{nd} Ed., Springer (2007).

Bloom's Taxonomy	CO1	CO2	CO3	CO4	CO5
K1: Remembering	1				
K2: Understanding	2	2	2		
K3: Applying				3	3
K4: Analyzing	4		4	4	4
K5: Evaluating		5			
K6: Creating					**3.09**

PGP / PSP 4340 **NANO PHYSICS** **4 hrs/3 Cr**

This course is designed to introduce the students to Basic concepts of crystal growth and its application, Characterization adopted in industries and scientific laboratories, Basic concepts of the nano particle. It also deals with Nano structure and its applications, Biological importance of nano materials

At the end of the course, students will be able to

i. explain the various techniques of crystal growth
ii. discuss the basics of Nanophysics and Methods of synthesis
iii. analyze quantum nanostructure and discuss its applications
iv. describe biological nanostructures, MEMS AND NEMS
v. compute nano particle size and structure using various instruments

UNIT I

Nucleation – Concept of nucleus formation – Shapes of nucleus – Phase diagrams and phase rules – Methods of melt growth – Vapour growth – Slow cooling – Gel growth – Etching techniques.

UNIT II

Introduction to Physics of the Solid State – Structure - Energy Bands - Localized Particles – Metal Nanoclusters- Magic Numbers - Theoretical Modelling of Nanoparticles - Magnetic Clusters – Semiconducting Nanoparticles – Optical Properties - Rare Gas and Molecular Clusters – Carbon Nanotubes – Methods of Synthesis - RF Plasma - Chemical Methods - Pulsed Laser Methods

UNIT III

Preparation of quantum Nanostructure – Size and dimensionality effects – Conduction Electrons and Dimensionality - Properties Dependent on Density of States - Excitons – Single-Electron Tunnelling – Applications – Superconductivity – Self-Assembly – Semiconductor Islands- Monolayers- Process of self-assembly- Catalysis- Porous Materials

UNIT IV

Biological Building Blocks – Nucleic Acids – Biological Nanostructures – Microelectromechanical Systems (MEMSs) – Nanoelectromechanical Systems (NEMSs) – Molecular and Supramolecular Switches

UNIT V

Atomic Structures – Crystallography – Particle Size Determination – Surface Structure – Transmission Electron Microscopy – Field Ion Microscopy – Scanning Microscopy – Spectroscopy of Semiconductors; Excitons – Infrared and Raman Spectroscopy – Brillouin Spectroscopy – Photoemission and X - Ray Spectroscopy – Magnetic Resonance – Luminescence

Text book:

1. P.S. Raghavan and P. Ramasamy, *Crystal Growth Process and Methods*, KRU publications (2000)
2. C.P. Poole Jr, F.J. Owens, *Introduction to Nanotechnology*, Wiley Students Edition (2007)

References:

1. Richard Booker & Earl Baysen, *Nano Technology*, Wiley (2005)
2. HuozhongGao, *Nano structures &Nanomaterials*, Imperial College press (2004)

Bloom's Taxonomy	CO1	CO2	CO3	CO4	CO5
K1: Remembering	**1**				
K2: Understanding		**2**		**2**	
K3: Applying					
K4: Analyzing	**4**		**4**		
K5: Evaluating			**5**		**5**
K6: Creating					
Mean					3.28

PGP / PSP 4342 **PHYSICS IN HUMAN PHYSIOLOGY** **4 hrs / 3 Cr**

This course enables learners to understand themusculoskeletal system, circulatory system, nervous system, auditory system andmetabolic processes of human body

At the end of the course, students will be able to

i. describe the behavior of human body under various forces
ii. explain the human functions under gravitational force
iii. identify the physics behind the blood flow in the human body
iv. relate the biological phenomenon to the physics of sound and heat
v. explain the physics of vision

Unit I: Forces and human body

Equilibrium and Stability - Equilibrium Considerations for the Human Body - Stability of the Human Body under the Action of an External Force - Skeletal Muscles - Levers - The Elbow - The Hip - The Back - Standing Tip-Toe on One Foot - Dynamic Aspects of Posture. Standing at an Incline - Friction at the Hip Joint - Spine Fin of a Catfish

Unit II: Motions and human body

Vertical Jump - Effect of Gravity on the Vertical Jump- Running High Jump - Range of a Projectile - Standing Broad Jump - Long Jump- Motion through Air - Energy Consumed in Physical Activity. Forces on a Curved Path - A Runner on a Curved Track - Pendulum - Walking - Physical Pendulum - Speed of Walking and Running - Energy Expended in Running - Alternate Perspectives on Walking and Running - Carrying Loads.

Unit III: Motion of Fluids and human body

Force and Pressure in a Fluid - Pascal's Principle - Hydrostatic Skeleton - Archimedes' Principle - Power Required to Remain Afloat - Buoyancy of Fish - Surface Tension - Soil - Insect Locomotion on Water - Contraction of Muscles – Surfactants.

Viscosity and Poiseuille's Law - Turbulent Flow - Circulation of the Blood - Blood Pressure - Control of Blood Flow - Energetics of Blood Flow - Turbulence in the Blood - Arteriosclerosis and Blood Flow - Power Produced by the Heart - Measurement of Blood Pressure.

Unit IV: Sound / Heat and human body

Energy Requirements of People - Energy from Food - Regulation of Body Temperature - Control of Skin Temperature - Convection - Radiation - Radiative Heating by the Sun - Evaporation - Resistance to Cold - Heat and Soil.

Properties of Sound - Hearing and the Ear - Bats and Echoes - Sounds Produced by Animals - Acoustic Traps - Clinical Uses of Sound - Ultrasonic Waves

Unit V: Optics/Electricity and human body

Vision - Nature of Light - Structure of the Eye - Accommodation - Eye and the Camera - Lens System of the Eye - Reduced Eye - Retina - Resolving Power of the Eye - Threshold of Vision - Vision and the Nervous System - Defects in Vision - Lens for Myopia - Lens for Presbyopia and Hyperopia - Extension of Vision.

The Nervous System- Electricity in the Bone- Electric Fish

Text book:

1. Paul Davidovits, *Physics in Biology and Medicine*, 3rd Edition, Academic press (2008).

Reference books:

1. VasanthaPattabhi and N. Gautham, *Biophysics*, Kluwer academic publishers, (2002).

Bloom's Taxonomy	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
K1: Remembering	**1**				
K2: Understanding		**2**			**2**
K3: Applying			**3**		
K4: Analyzing				**4**	
K5: Evaluating		**5**		**5**	
K6: Creating					
Mean					3.0

PGP / PSP 4344 **SUSTAINABLE ENERGY RESOURCES** **4 hrs / 3 Cr**

This course deals with the principles of renewable energy, energy conversion systems, thermal energy systems and energy storage systems.

At the end of the course, students will be able to

i. distinguish the characteristics of renewable energy.
ii. explain the significance of solar radiation and their applications
iii. explain the energy extraction from wind, tides and organic substances.
iv. describethe thermal energy conversions in ocean and earth's core.
v. interpret different forms of energy storage and their transmission.

Unit I: Principles of Renewable Energy

Fundamentals - Scientific principles of renewable energy - Technical implications - Social implications - Heat transfer - Heat circuit analysis and terminology - Conduction - Convection - Radiative heat transfer - Properties of transparent materials - Heat transfer by mass transport.

Unit II: Solar Energy Systems

Solar radiation - Measurements of solar radiation- Solar water heating - Evacuated collectors - Solar ponds - Solar concentrators - Solar thermal electric power systems –Photo-voltaic generation - Solar radiation absorption - Types of photo-voltaicsystemsand their Applications

Unit III: Energy Conversion Systems

Power from the wind - Turbine types and terms - Characteristics of the wind - Power extraction by a turbine - Electricity generation - Mechanical power - Biomass and biofuels - Biofuel classification - Biomass production for energy farming - Direct combustion for heat - Pyrolysis (destructive distillation) - Anaerobic digestion for biogas - Vegetable oils and biodiesel - Tidal power - The cause of tides - Tidal current/stream power - Tidal range power.

Unit IV: Thermal Energy Systems

Ocean thermal energy conversion (OTEC) - Principles - Heat exchangers - Pumping requirements - Environmental impact - Geothermal energy - Geophysics - Dry rock and hot aquifer analysis - Harnessing Geothermal Resources.

Unit V: Energy Storage Systems

Energy systems, storage and transmission - The importance of energy storage and distribution - Biological storage - Chemical storage - Heat storage - Electrical storage: batteries and accumulators - Fuel cells - Mechanical storage.

Text Book:

1. John Twidell and Tony Weir, *Renewable Energy Resources*, 2nd edition, London, Taylor & Francis Group, (2006).

References:

1. D. Y. Goswami, F. Kreith and J. F. Kreider, *Principles of Solar Engineering*, Philadelphia, Taylor and Francis, (2000).
2. L.L. Freris, *Wind Energy Conversion Systems*, Prentice Hall, (1990).
3. C. S. Solanki, *Solar Photovoltaics: Fundamental Applications and Technologies,* Prentice Hall of India, (2009)
4. S.P. Sukhatme, *Solar Energy: principles of Thermal Collection and Storage*, Tata McGraw-Hill (1984).
5. E H Thorndike, *Energy & Environment: A Primer for Scientists and Engineers,* Addison-Wesley Publishing Company, (1976)

6. R Wilson & W J Jones, *Energy, Ecology and the Environment*, Academic Press Inc. (1975)

Bloom's Taxonomy	CO1	CO2	CO3	CO4	CO5
K1: Remembering	**1**				
K2: Understanding	**2**	**2**			**2**
K3: Applying				**3**	
K4: Analyzing			**4**		
K5: Evaluating		**5**		**5**	
K6: Creating					
Mean					

PGP / PSP 4346 **PHYSICS LAB - II** **9 hrs / 3 Cr**

The laboratory sessions are designed to inculcate good laboratory practice and work habits. This is also a place to reinforce the concepts and techniques presented in the lectures. This course also teaches the students to get acquainted with data and error analysis and offers hands-on experience with modern instrumentation and soft skills.

At the end of the course, students will be able to

i. practice systematic laboratory work habits.
ii. design experiments and verify theoretical concepts
iii. perform Data and error analysis
iv. handle advanced equipment in the lab
v. troubleshoot physics experiments

Total of 16 Experiments: **Any 8 from the following:**

1. Hall Effect - Hall coefficient, Hall voltage, carrier density and mobility.
2. GM counter - counter plateau and resolving time
3. CDS - arc spectrum
4. Michelson interferometer - optical bread board - refractive index of gas
5. Ultrasonic interferometer - Physical parameters of pure and binary liquids - dielectric constant, verification of iterative equations
6. XRD – Determination of structural parameters
7. Determination of Hysteresis loss – tracing B-H loop on the CRO
8. Free fall – displacement-time graph, g calculation using charging and discharging
9. Four probe - Measurement of sheet resistance, resistivity, Energy gap -thin films, silicon & aluminum foil.
10. Susceptibility - electro magnet - Quinke's method – liquid
11. Microwave - Characteristics, dielectric constant in liquid and solids
12. Thick lens systems – nodal points – optical bench
13. Charge of the electron - using spectrometer.
14. MATH-CAD – Graphics and Mathematical analysis

Any 8 from the following:

15. Pulse Width Modulation - Study & DC motor control.
16. Op-Amp - logarithmic and Anti logarithmic amplifier, current to voltage converters and voltage to current converters
17. FM Modulation and demodulation.
18. Experiments in physics with expEYE-17.
19. Lab view –multiplexer and demultiplexer
20. Stepper motor control - using micro controller.
21. Design of counters – using flip flops, MOD counters using 7490.
22. FET – characteristics – Vp, I_{DSS}, gm, rd.
23. Analog computation using - OP-AMP.
24. D/A conversion - (R-2R and weight network).
25. Instrumentation amplifier.
26. Study of RAM – using ICs.

Bloom's Taxonomy	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
K1: Remembering	1				
K2: Understanding	2		2		
K3: Applying		3			3
K4: Analyzing		4	4	4	
K5: Evaluating				5	
K6: Creating					
Mean					

PGP / PSP 5431 NUCLEAR & PARTICLE PHYSICS 5 hrs / 4 Cr

This course enables students to acquire knowledge of basic properties of nucleus and the nature of nuclear forces. It introduces the concepts of radioactivity and students get an insight into nuclear reactions. Also it helps students to gain the knowledge on elementary particles.

At the end of the course, students will be able to

i. explain the structure of nucleus, its stability and various nuclear models
ii. categorize various nuclear decay process and the associated selection rules
iii. discuss the nature of nuclear forces
iv. elucidate key features of nuclear fission reactors and fusion reactions
v. classify elementary particles and quark states using group theory

Unit I: Nuclear Structure and Models

Nuclear size –theories of nuclear composition-binding energy- semi empirical mass formula of Weizsacker - nuclear stability – Fermi gas model – liquid drop model – shell model - magic numbers - extreme single particle model- predictions of shell model- Unified model.

Unit II: Radioactivity

Geiger Nuttal law- fine structure of alpha spectra- Gamow's theory of alpha decay- beta decay- Neutrino hypothesis- Fermi's theory of beta decay- Kurie plots- Fermi and G.T.Selection rules- Non- conservation of parity in beta decay- Gamma emission- internal conversion- nuclear isomerism.

Unit III: Nuclear Scattering and Reactions

Nuclear forces-deuteron-low energy n–p scattering- phase shift, scattering length- p-p scattering at low energies- n-n scattering- types of nuclear reactions-Conservation laws- Q-equation- endoergic and exoergic reactions- nuclear cross section-Breit- Wigner one level formula- Direct reactions

Unit IV: Nuclear Fission and Fusion

Nuclear fission: types of fission-fission cross section- fission isomer-deformation of liquid drop-Bohr and Wheelers theory of nuclear fission-parity violation in fission- nuclear fusion and thermonuclear reactions- controlled thermonuclear reactions-nuclear fission reactor: nuclear chain reaction-four factor formula-critical size of a reactor.

Unit V: Elementary Particles

Introduction- classification of elementary particles- fundamental interactions- conservation laws- conservation of isospin- strangeness- hypercharge-Gell-Mann Nishijima relation-charge conjugation- parity- Combined Inversion- time reversal- combined inversion of CPT-neutrino and antineutrino-graviton, photon and gluon-elementary particle symmetry- SU(2) group- SU(3) group- quarks model.

Text Books:

1. D.C.Tayal, *Nuclear Physics*, Himalaya Publishing house, New Delhi (2013)

References:

1. H.A. Enge, *Nuclear Physics*, Addison Wesley Pub. Co, London(1969)
2. R.C. Sharma, *Nuclear Physics*, Wily Eastern Ltd, New Delhi.(1980)
3. V.Devanathan, *Nuclear Physics*, Narosha Publishing House, New Delhi (2006).

Bloom's Taxonomy	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
K1: Remembering	1				
K2: Understanding	2		2	2	
K3: Applying	3	3			3

K4: Analyzing		4	4		4
K5: Evaluating				5	
K6: Creating					
Mean					

PGP/PSP5433<u>ELECTRODYNAMICS AND PLASMA PHYSICS</u> 4 hrs/4 Cr

To apprise the students regarding the concepts of electrodynamics and Maxwell equations and use them various situations. Also the course introduces the students to elementary phenomena and concepts in plasma physics.

At the end of the course, students will be able to

i. describe electrostatic phenomenon using method of images and boundary value approach
ii. explain magneto-statics phenomenon and construct Maxwell's equations
iii. describe propagation of electromagnetic waves in different media using Maxwell's equations
iv. elucidate the production of electromagnetic waves and derive the relativistic electro dynamic field equations
v. explain elementary phenomena and concepts in plasma physics.

UNIT I: Electrostatics

The Electric field – Differential form of Gauss Law – Applications of Gauss Law – Poisson's Equation and Laplace's Equation- The Method of Images - Boundary Value Problems – Multipole Expansion - Electric fields in Matter – Polarization – Bound Charges – Electric Susceptibility - Boundary value problems with linear dielectrics

UNIT II Magneto statics& Maxwell's Equations

The Biot-Savart Law – The Divergence and Curl of Magnetic field – Ampere's Law – Magnetic Vector Potential – Magnetic Fields in Matter – Magnetization - Bound Currents – Magnetic Susceptibility – Maxwell's Equations: Electrodynamics Before Maxwell - Magnetic Charge - Maxwell's Equations in Matter - Boundary Conditions-Electromagnetic waves in Vacuum - The Wave Equation for E and B - Monochromatic Plane Waves - Energy and Momentum in Electromagnetic Waves -

UNIT III Propagation of EM Waves

Electromagnetic Waves in Matter – Propagation in Linear Media - Reflection and Transmission at Normal Incidence and Oblique Incidence – Fresnel's equation - Electromagnetic Waves in Conductors - Reflection at a Conducting Surface - Wave Guides - TE Waves in a Rectangular Wave Guide - The Coaxial Transmission Line

UNIT IV Radiation of EM Waves & Relativistic Electrodynamics

Dipole Radiation: Electric Dipole Radiation - Magnetic Dipole Radiation – Radiation from an Arbitrary Source - Electric and Magnetic fields and Total Radiated Power - Point Charges - Power Radiated by a Point Charge; **Relativistic Electrodynamics** - The Field Tensor – Electrodynamics in Tensor Notation - Relativistic Potentials – Maxwell's equations.

UNIT V: Introduction to Plasma Physics

General Properties of Plasma – Debye Shielding – The Occurrence of Plasma in Nature - Applications of Plasma Physics: Controlled Thermonuclear Fusion – The Magneto-hydrodynamic Generator – Plasma Propulsion – Plasma Devices – Theoretical Description of Plasma Phenomena; Charged Particle Motion in Non-uniform magneto-static fields: Gradient Drift – Magnetic Mirror Effect.

Text Books:

1. J. H. Griffiths, 3rd ed., *Introduction to Electrodynamics*, Prentice-Hall of India Pvt Ltd, New Delhi (2013).
2. J. A. Bittencourt, *Fundamentals of PLASMA PHYSICS*, 3rd Ed., Springer-Verlag, NewYork (2004)

References:

1. Dale Corson& Paul Lorrain, 2ndedn, *Electromagnetic fields and waves*, CBS Publishers, New Delhi(1988)
2. J.D.Jackson ,*Classical electrodynamics*, John Wiley, New York(1978).
3. Francis F. Chen, 2ndedn, *Introduction to Plasma Physics and controlled Fusion* (Vol. I), Plenum Press, New York

Bloom's Taxonomy	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
K1: Remembering	1				
K2: Understanding	2	2			2
K3: Applying		3	3		
K4: Analyzing				4	
K5: Evaluating			5	5	
K6: Creating					
Mean					

PGP/PSP5435 **PHYSICAL ELECTRONICS** **4 hrs / 4 Cr**

This course aims to provide students with knowledge of conduction in electronic devices, the theory behind conduction mechanism, Field effect transistors, microwave devices and photonic devices.

At the end of the course, students will be able to

i. explain the phenomena of conduction in metals
ii. describe electrical conduction in semiconductors
iii. account for charge transport across semiconductor junctions
iv. describe the operations of FET and microwave devices
v. elucidate the physics of photonic devices

UNIT-1 Conduction in metals

Electron volt - unit of energy - current density - motion in a magnetic field - Nature of the atom - energy band theory of crystals - insulators - semiconductors - conductors- Conduction in metals - potential energy field in a metal - bound and free electrons - energy density - Fermi level -density of states - work function .

UNIT-2 Theory of semiconductors

Conduction in semiconductors - electrons and holes - conductivity - carrier concentration in conduction and valence band - intrinsic concentration- effective mass - fermi level in an intrinsic and extrinsic semiconductor - donor acceptor impurity - charge density in a semiconductor - Diffusion - carrier life time - The continuity equation- Hall effect.

UNIT-3 Semiconductor Diode

Semiconductor diode characteristics - qualitative theory - P-N junction as a diode - Metal-semiconductor junctions, Schottky diode- ohmic contacts - open circuited p-n junction. Theory of p-n diode forward and reverse currents - the volt-ampere characteristics - diode resistance - transition and diffusion capacitance

UNIT-4 FET and microwave Devices

JFET- construction - characteristics - small signal model - FET as voltage and current regulator - homo and hetero junction devices - the MOSFET transistor, CMOS technology, the UJT - frequency dependence and applications. Tunnel - Gunn diode - IMPATT diode - Klystron - travelling Magnetron and back ward oscillators - working, characteristics and applications.

UNIT-5 Physics of Photonic Devices

Basic monolithic circuits - monolithic diode - integrated resistor - integrated capacitors and inductors - Radiative and non-radiative transitions - optical absorption- photo emissivity - photo tubes - photo multiplier tubes - photo conductivity - photo diode - laser diode - photo voltaic effect - solar cell - photo detectors - LED- OLED.

Text Books:

1. Christos C. Halkias, SatyabrataJit, Jacob Millman, (2015) *Electronic devices and circuits*, 4e ,Mcgraw hill publishing company.

References:

1. Samuel Y. Leo, Microwave Devices and Circuits. Third Edition. Prentice hall, Englewood Cliffs, New Jersey.
2. Bill Wilson, Introduction to Physical Electronics (2010) Connexions publications

Bloom's Taxonomy	CO1	CO2	CO3	CO4	CO5
K1: Remembering	1				
K2: Understanding	2		2		
K3: Applying		3			3
K4: Analyzing			4	4	
K5: Evaluating		5		5	
K6: Creating					
Mean					

PGP/PSP 5437 **LASER & SPECTROSCOPY** **4 hrs/ 4 Cr**

This Course deals with the basic physics behind laser operation, the different laser systems and their applications like interaction with matter and information processing. Physical and Chemical processes in molecular systems are also analyzed through various spectroscopic methods in different regions of electromagnetic spectrum.

At the end of the course, students will be able to

i. explain the theory of lasers and its line broadening mechanism.
ii. describe the design characteristics of optical cavities for laser systems.
iii. elucidate rotational and vibrational spectroscopy
iv. discuss Raman and electronic spectroscopy
v. describe the theory ofresonance spectroscopy

UNIT I: LASER - I

Einstein Coefficients – Light amplification – Threshold condition – Laser rate equations – Three level system – Four level system – Variation of laser power around threshold – Optimum output coupling – Line broadening mechanisms.

UNIT II: LASER - II

Modes of a rectangular cavity and the open planar resonator – Quality factor – Ultimate line width of a laser – Mode selection – Q - Switching – Mode locking in lasers – Modes of a confocal resonator system

UNIT III Rotational and Vibrational Spectroscopy

Types of molecules – Rotational spectra of rigid and non-rigid rotators – Intensity of rotational lines– Effect of isotopic substitution –Stark modulated microwave spectrometer – Vibrational spectra of simple harmonic oscillator – Anharmonic oscillator – vibrating rotator – IR Spectrometer.

UNIT IV: Raman and Electronic Spectroscopy

Classical and quantum theory of Raman effect – Pure rotational Raman Spectra – Vibration Raman spectra – Raman activity of vibrations – Raman spectrometer – Vibrational coarse structure – Frank Condon principle – Rotational fine structure – Dissociation and pre dissociation – Deslander's table – Fortrat parabola – Photo-electron spectroscopy.

UNIT V: Resonance Spectroscopy

Interaction of spin and applied magnetic field – Relaxation processes – Chemical shift – Coupling constant – NMR spectrometer – Principles of electron spin resonance – Multiplet structure – ESR spectrometer - Mössbauer effect – Recoilless emission of gamma rays.

Text Books:

1. A.K. Ghatak& K. Thyagarajan, *Optical Electronics*, Cambridge University Press, Cambridge, (1989).
2. G.N. Banwell& E.M. Mccash, *Fundamentals of Molecular Spectroscopy*, 4th Ed. Tata McGraw Hill Publishing, (2000).

References:

1. P.W. Milonni,& J.H. Ederly, *Lasers*, John Wiley & Sons, (1988).
2. G. Aruldhas, *Molecular structure and spectroscopy*, Prentice Hall, India, (1997).

Bloom's Taxonomy	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
K1: Remembering	1				
K2: Understanding	2	2			
K3: Applying				4	
K4: Analyzing		4	4		4
K5: Evaluating				5	
K6: Creating					
Mean					

PGP/PSP 5439 **QUANTUM MECHANICS -II** **4 hrs/4 Cr**

This course gives an insight of applying different approximation methods for stationary states and deals with alternative pictures of time evolution and relativistic quantum mechanics. It also helps the students to acquire basic knowledge of quantum field theory.

At the end of the course, students will be able to

i. apply different approximation methods for stationary states.
ii. describe the time evolution of quantum systems and discuss matter radiation interaction
iii. differentiate Schrodinger, Heisenberg and Dirac pictures and quantum theory of photon interaction

iv. describe the relativistic quantum phenomena and account for electron spin and electron magnetic moment.

v. AnalyzeFermi and Bose systems using quantum field theory

Unit I: Approximation methods for stationary states

Perturbation theory for discrete levels: Non-Degenerate and Degenerate case - Stark Effect - Two electron Atoms; The variational method: Upper bound on ground state energy - Application to excited states – The Hydrogen Molecule; The WKB Approximation: The Bohr-Sommerfeld quantum condition

Unit II: Evolution with Time

Exact Formal Solutions: Propagators – Relation of Retarded propagator to the Green's function; Perturbation Theory for time evolution problems: Perturbative solution for transition amplitude–Selection Rule - First order transitions – Fermi's Golden rule – Harmonic perturbations – Interaction of an Atom with EM Radiation – The Dipole Approximation – The Einstein's coefficients.

Unit III:Alternative Pictures of Time Evolution

The Schrodinger Picture – The Heisenberg Picture – Matrix Mechanics - The Simple Harmonic Oscillator - Electromagnetic wave as Harmonic Oscillator: Photons – Atom Interacting with Quantized Radiation: Spontaneous Emission – The Interaction Picture – Time Evolution of Ensembles: Density Matrix.

Unit IV: Relativistic Wave Equations

The Klein-Gordon Equation – Plane wave solutions - Interaction with Electromagnetic Fields: Hydrogen-like Atom; The Dirac Equation: Dirac's Relativistic Hamiltonian – Dirac Matrices – Plane wave solutions and Energy Spectrum - The Spin of the Dirac Particle –Spin Magnetic Moment – The Spin orbit Energy.

Unit V: Introduction to Quantum Field Theory

Lagrange's Classical Field Equation – Quantization of the field: Schrodinger Field– Commutation Algebra for Bosons & Fermions-Relativistic fields: Klein-Gordon field- Dirac field - Quantization of EM field.

Text Books:

1. P. M. Mathews & K. Venkatesan, *A Text Book of Quantum Mechanics*, 2^{nd} Ed., Tata McGraw Hill, New Delhi (2013)
2. G. Aruldhas, *Quantum Mechanics*, 2^{nd} Ed., PHI Learning Private limited, New Delhi (2018)

References:

1. Schiff L.I. *Quantum Mechanics*, 3rd Ed., McGraw Hill New York (1968).
2. G. Aruldhas, *Quantum Mechanics*, 2nd Ed., PHI Learning Private limited, New Delhi (2013).
3. Thankappan V. K. *Quantum Mechanics*, 2nd Ed., New Age International (P) Ltd, New Delhi (1993).
4. Ajay &Ghatak, *Quantum mechanics Theory and applications*, Mac Millan, (2003).
5. MezbacherE "*Quantum Mechanics*" 2nd Ed, John Wiley & Sons Inc, (1970).

Bloom's Taxonomy	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
K1: Remembering	1	1			
K2: Understanding				2	
K3: Applying	3				
K4: Analyzing		4			4
K5: Evaluating			5	5	
K6: Creating					

PGP/PSP 5441 **<u>PROJECT – I</u>** **9 hrs/4 cr**

This course enables the Students to have hands-on experience in the design experiments / methodologies and record the process of measurements. He will also learn to correlate with the respective theoretical concepts and draw non-trivial conclusions of the significance of the observations.

At the end of the course, students will be able to

i. define problems, formulate hypotheses, test hypotheses, analyse, interpret and draw conclusions from data;

ii. identify relevant assumptions or implications; formulate coherent arguments;

iii. act together as a group or a team in the interests of a common cause and work efficiently as a member of a team;

iv. use ICT and demonstrate ability to access, evaluate, and use a variety of relevant information sources;

v. communicate with others using appropriate media; confidently share one's views and express herself/himself.

Students are given the freedom of choosing the topic of the project and approved by the staff supervisor/ guide. It may be theoretical or experimental. After getting approval of the proposed project work within 5 sessions, students are supposed to carry out these projects in the department laboratory. Students shall maintain daily records and present at least two oral progress reports while doing the project. They shall submit the dissertation at the end of the semester. Students are encouraged to have hands-on experience in designing, fabricating, and analyzing the observations using fundamental concepts studied in the course of study.

Evaluation Method For Project:

1. Project Proposal (Oral and written) 20%
2. Oral progress reports 20%
3. Continuous assessment 35%
4. Final Report 25%

Bloom's Taxonomy	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
K1: Remembering	1				
K2: Understanding	2				
K3: Applying	3		3	3	
K4: Analyzing	4	4		4	
K5: Evaluating	5				5
K6: Creating					
Mean					

PGP/PSP 5432 **<u>THIN FILMS & VACUUM TECHNOLOGY</u>** **4 hrs/4 Cr**

This course introduces students to the theory and practice of high vacuum systems as well as thin film deposition. Students will have hands on experience of system operation, thin filmcoating and design. This course also introduces the students to various characterization techniques adopted in industries and scientific laboratories.

At the end of the course, students will be able to

i. identify and explain different high vacuum system and its components
ii. distinguish between different types of coating procedures
iii. explain the physics of thin film growth
iv. analyze and interpretthe characteristics of thin film
v. describe the properties and applications of thin films

UNIT I: Production of High Vacuum

Production and maintenance of high and ultrahigh vacuum systems - Kinetics of vacuum - Low and high vacuum – high vacuum materials - Gas transport - conductance - pumping - Vacuum pumps - vacuum gauges -types of valves and flanges - Types of vacuum systems and their components - types of leakages. system switching ON and OFF procedure.

Lab: Pump down characteristics, flow rate determination, McLeod's gauge,Identifyingtypes of valves and flanges.

UNIT II: Physical evaporation Process

Physical vapour deposition - evaporation rate - Evaporation of alloys- Film thickness uniformity and purity- Thermal evaporation - source heaters - substrate materials and cleaning - Glow discharge - plasma species - Sputtering systems, its types - sputter yield - alloy sputtering - RF sputtering - PLD process and coating - Evaporation Vs Sputtering.

Lab: Demonstration of thermal and sputtering coating- Hard coatings

Unit III: Growth and Chemical Coating Process

Film formation and structure: growth process- basic models - kinetic models of nucleation - theory of homogeneous and heterogeneous nucleation - nucleation rate - sticking coefficient - compar. **Chemical vapour deposition** - Reaction types - CVD process and systems - Low and high temperature systems - LPCVD, PECVD, LECVD, MOCVD - safety.

Unit IV: Surface and thickness of thin films

Film thickness - micro balance - quartz crystal monitor - Profilometer (stylus) - ellipsometry - photometric method- spectro photometric method - FIZEAU and FECO methods - structural analysis, LEED, HEED, SEM, TEM, AES, EDAX and XPS (Description only).

Lab:–Thickness measurement usingmicrobalance, quartz crystal, profile meterandFizeau method.

Unit V: Properties and application of thin films

Hardness and corrosion of thin films - adhesion test -hard and protective coatings.Electricalproperties - General definitions - film resistivity - four probe, Conduction and TCR of continuous and discontinuous thin films. Optical properties - General definitions - non absorbing films - one and two interfaces - Absorbing films. Thin film resistors– antireflection coatings – Transparent conducting coatings.

Lab: study of reflection, transmission curves of UV-visible spectrophotometer & determination of n and k values – Optical E_g determination - E_g of thin films four probe method.

Text Books:

1. Milton Ohring, 2006, *The material science of thin films*, 2ed , Academic press limited.

2. K. L Chopra 1969, *Thin film phenomena,* McGraw hill book company.
   Chapter II, III, IV, V VI, XI relevant topics.

References:

1. Andrew Guthrie, 1963 "*Vacuum technology*" John Wiley& sons, Inc.

2. T. J. Coutts 1974 "*Electrical conduction in thin metal films*" Elsevier scientific publishing company.
3. L.I.Maissel and R.Glang 1970. "*Handbook of Thin Film Technology*" McGraw Hill Book Company, New York.

Bloom's Taxonomy	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
K1: Remembering	1				
K2: Understanding	2		2		
K3: Applying		3			3
K4: Analyzing		4	4	4	
K5: Evaluating				5	
K6: Creating					
Mean					

PGP/PSP 5434 **CONDENSED MATTER PHYSICS – II** **4 hrs/4 Cr**

This course enables learners to acquire knowledge of energy bands in crystals, understand the different classification of materials, translate the learned information to a variety of quasi particles, present reasoned explanation for various superconducting effects and apply the systematic approach to problem solving in dielectrics and Ferro electrics

At the end of the course, students will be able to

i. derive and explain the electrical properties of crystals
ii. explain the theory of quasi particles and their characteristics
iii. classify the types of superconductors and explain its properties
iv. explain the origin of dielectric and Ferro-electric phenomena
v. describe quantum theory of magnetism and classify magnetic materials

Unit I:Fermi Gas and Energy Bands:

Free electron theory in 1D and in 3D – Fermi-Dirac distribution – Density of states – Heat capacity of the electron gas – Electrical conductivity and Ohm's law – Motion of electrons in magnetic field – Hall Effect – Nearly free electron model – Bloch functions – Kronig-Penney model.

Unit II:Plasmons, Polaritons, Polarons and Excitons

Dielectric function of the electron gas – Plasma Optics – Transverse and Longitudinal modes of Plasma – Plasmons – Polaritons – LST equation – Polarons, Optical Reflectance-Kramer-Kronig relation –Excitons- Frenkel and Mott-Wannierexcitons

Unit III:Superconductivity:

Experimental survey – Destruction of superconductivity by magnetic field – Meissner effect – Isotopic effect – Type I and Type II superconductors – London equation – Coherence length – BCS theory of superconductivity – Flux quantization – Vortex state – DC and Ac Josephson effect – High temperature superconductors – Fullerenes

Unit IV:Dielectric and Ferro electrics

Macroscopic electric field – Local electric field at an atom – dielectric constant and Polarizability – Classius-Mossati equation – electronic polarizability and its frequency dependence – Structural phase transitions – Ferro electric crystals – Displacive transition – Landau theory of phase transition – antiferroelectric materials –Piezoelectricity-Ferroelasticity

Unit V:Magnetism

Quantum theory of dia and para magnetism- Rare earth ions- Hund's rule- Orbital quenching-Paramagnetic susceptibility of conduction electrons- Ferromagnetic order- antiferromagnetic order- Magnons, thermal excitons of magnons , spin waves

Text Book:

1. Charles Kittel, *Introduction to Solid State Physics*, 5th edition.

References:

1. S.O Pillai(1997), *Solid State Physics*, Wiley Eastern Lmt.
2. S.V Subramanian, E.S Rajagopal(1989), *High Temperature Super conductivity*, Wiley Eastern Lmt
3. H.V Keer(1994), *Principles of Solid State,* Wiley Eastern Lmt.
4. M.A.Wahab(1999), *Solid State Physics*, Narosa Publishing house, Delhi

Bloom's Taxonomy	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
K1: Remembering	**1**				
K2: Understanding		**2**	**2**		
K3: Applying					**3**
K4: Analyzing		**4**		**4**	
K5: Evaluating			**5**		
K6: Creating					
Mean					

PGP/PSP 5436 **ANALOG ELECTRONICS** **4 hrs/4 Cr**

This course enables the students to understand mainly the operational amplifier in detail and to analyse the different modes of operation.
At the end of the course, students will be able to

i. interpret the theory behind the modes of operation
ii. analyse theoretically, the different types of filters and their characteristics
iii. describe the non-linear models of operational amplifiers
iv. design and explain oscillator circuits
v. explain the limitations in the use of operational amplifier and apply it for constructing amplifiers and oscillators.

Unit I: OP-AMP Introduction

Amplifier fundamentals - Ideal OP-AMP model-frequency response OP-AMP testing circuit - impact of virtual ground - difference amplifier - negative feed -back-real inverting OP-AMP - real non-inverting OP-AMP

Unit II: Active Filters

Transfer function - Bode plot-first order low pass filter - first order high pass filter-first order band pass filter –band reject filter- second order responses - Salen-key second order low pass filter - KRC second order low pass filter - Salen-key second order high pass filter - KRC second order high pass filter - second order band pass filter.

Unit III: Non linear circuits

Positive feed - back - voltage comparator - threshold detector - level detector -window detector - pulse width modulation - Schmitt trigger - inverting Schmitt trigger - non-inverting Schmitt trigger - Analog switches - peak detector - sample and hold circuits.

Unit IV: Signal Generators

Practical Wien's bridge oscillator - multi-vibrators - CMOS Gate multi-vibrator -CMOS crystal oscillator - voltage controlled oscillator - Triangle to sine wave converter.

Unit V: Limitations and Applications

Input bias-offset current-low input bias-input offset voltage-low input offset voltage OP-AMPs-slew rate limiting-current to voltage converter-photo detector amplifier-charge amplifier-Instrumentation amplifier-transducer bridge amplifier-log amplifier-anti log amplifier

Text Book:

1. Sergio Franco, *Design with Operational Amplifiers and Analog Integrated Circuits*, McGraw - Hill Book Company, 4th Edition (2014).

References:

1. G.J Deboo and C.N.Burrous, *Integrated circuits and semiconductor devices*, McGraw Hill,Kogakusha Ltd. (1977).

Bloom's Taxonomy	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
K1: Remembering	1				
K2: Understanding	2		2		
K3: Applying		3		3	3
K4: Analyzing				4	
K5: Evaluating		5			5
K6: Creating					
Mean					

PGP/PSP 5438 **<u>THERMODYNAMICS & STATISTICAL PHYSICS</u>** **4hrs/ 4 Cr**

This course helps students to understand the laws involving statistical techniques & its application to physics. Various quantum statistical models are proposed & their appropriate involvement in understanding physical behavior of system of particles is discussed.

At the end of the course, students will be able to

i. solve problems related to heat and thermodynamics using the laws of thermodynamics and thermodynamic potentials
ii. define statistical ensembles and use partition function to derive the thermodynamic properties of two level system and ideal gas model
iii. explain the thermodynamic properties of Black body radiation, degenerate Fermi gas and Bose gases using quantum statistics
iv. identify the order of phase transitions, explain its properties using Clayperon latent heat equation and Landau theory and calculate the energy transfer involved in phase transitions
v. appreciate the role of non-equilibrium statistics in nature and explain its origin using physical laws

Unit I: Thermodynamics
Introduction- Review of Thermodynamic laws- Carnot Engines- Entropy- Approach to Equilibrium and Thermodynamic Potentials- Enthalpy, Helmholtz free energy and Gibb's free energy- Useful Mathematical Results: Extensivity, Maxwell's Relations- Gibb's Phase Rule- Stability Conditions- Consequences of the Third Law

Unit II: Classical Statistical Mechanics

The Microcanonical Ensemble- Two-Level Systems- Ideal Gas- Mixing Entropy And The Gibbs Paradox- Canonical Ensemble- Partition Function- Canonical Examples(Two-Level Systems and Ideal Gas)- Gibbs Canonical Ensemble- Grand Canonical Ensemble

Unit III: Quantum Statistical Mechanics

Black-Body Radiation- Quantum Microstates- Quantum Macrostates-Hilbert Space of Identical Particles- Canonical Formulation- Grand Canonical Formulation- Non-Relativistic Gas- Degenerate Fermi Gas- Degenerate Bose Gas – Bose Einstein Condensation- Superfluid He^4

Unit IV: Phase Transitions

First Order Phase Transition- Condition For Phase Co-Existence- Clayperon Equation-Van Der Waal's Equation of State- Virial Expansion- Critical Point- Maxwell's Construction- Order Parameter- Landau Theory- Relation To Microscopic Theory- Functional Integration And Differentiation- Second Order Phase Transition- Mean Field Theory- Critical Exponents- Correlation length.

Unit V: Elements of Non-Equilibrium Statistical Mechanics

Thermal Fluctuations- Nyquist Noise- Brownian Motion- Einstein Theory- Diffusion- Einstein's Relation- Ensemble of Paths- Ensemble Average- Power Spectrum And Correlation Function- Signal And Noise- Transition Probabilities- Markov Process- Fokker Planck Equation- Langevin Equation.

Text Books:

1. MehranKardar, *Statistical Physics Of Particles*, Cambridge University Press, 3 Edition (2010)
2. Kerson Huang, *Introduction To Statistical Physics*, Chapman and Hall/CRC,2 Edition, (2009)

References:

1. R. K. Pathria and Paul D. Beale, *Statistical Mechanics*, 3rd ed. Academic Press (2011)
2. Walter Greinear, Ludwig Neise and Stocker, *Thermodynamics and Statistical Mechanics*, Springer, (1997)
3. V. Balakrishnan, *Elements Of Non equilibrium Statistical Mechanics*, Ane Books Pvt. Ltd. (1997)
4. Kerson Huang, *Statistical Mechanics*, 2nd ed., Publisher: John Wiley (2008)

Bloom's Taxonomy	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
K1: Remembering	**1**				
K2: Understanding			**2**		**2**
K3: Applying	**3**	**3**	**3**		
K4: Analyzing				**4**	
K5: Evaluating		**5**		**5**	
K6: Creating					
Mean					

PGP/PSP 5440 **MATRIX, FOURIER AND NON LINEAR OPTICS** **4hrs/ 4 Cr**

This course enables the students to the use of matrix methods and Fourier and Non-linear techniques in optics. Effectively, this is an applied mathematics course, taught with a systems flavor, for students interested in optics.

At the end of the course, students will be able to

i. apply matrix methods in optics.
ii. describe the characteristics of two dimensional Fourier transform and explain the analysis of linear optical systems.
iii. explain the theory of construction and reproduction of holograms and its applications
iv. elucidate the propagation of light in anisotropic media and electro-optic effect
v. discuss acousto-optic effect and non-linear phenomena in crystals

Unit I: Matrix Methods in Optics

Paraxial Optics: Ray transfer matrices – Translation and refraction matrix – Derivation of properties of a system from its matrix – Experimental determination of the matrix elements of an optical system. Polarization Optics: Jones Matrices – Experimental determination of the elements of a Jones matrix or a Maxwell Column.

Unit II: Fourier Optics

Fourier analysis in two dimensions – Scalar diffraction theory – Integral theorem of Helmholtz and Kirchhoff – Kirchhoff formulation of diffraction by a planar screen – Rayleigh-Sommerfeld formulation of diffraction – Comparison of Kirchoff and Rayleigh-Sommerfeld theories – A thin lens as a phase transformation - Fourier Transforming properties of lenses.

Unit III: Holography

Wavefront Reconstruction – Gabor Hologram – Leith-Upatnieks hologram – Fourier - Transmission and reflection holograms – Recording Materials – Applications: Microscopy, Interferometry, Vibration Analysis, Holographic data storage.

Unit IV: Crystal Optics & Electro Optic Effect

Plane waves in anisotropic media – wave refractive index – ray refractive index – index ellipsoid – index ellipsoid in the presence of external electric field – Electro optic effect: Electro optic effect in KDP.

Unit V: Acousto and Non Linear Optic Effect

Raman – Nath diffraction – Theory of Raman – Nath diffraction – Bragg diffraction – Raman Nathacousto optic modulator – Bragg modulator – Self focusing phenomenon – second harmonic generation

Text Books:

1. Gerard A & Burch J.M, *Introduction to Matrix Methods in Optics*, John Wiley, (1975).
2. Goodman J. W, *Introduction to Fourier Optics*, McGraw Hill, New York, (1996).
3. Ghatak. A. K &Thyagarajan. K, *Optical Electronics*, Cambridge University Press, Cambridge, (1989).

References:

1. Gaskill J.D, Linear Systems, *Fourier Transforms and Optics*, John Wiley, (1975).
2. Pedrotti F. L and Pedrotti L.S, *Introduction to Optics*, Pretice Hall Inc, (1987).
3. Grant R. Fowles, *Introduction to Modern Optics*, Holt, Rinehart & Winston Inc, (1975).
4. Born M and Wolf E, *Principles of Optics*, Pregamon Press, Oxford, (1975).
5. Nussbaum A and Philips R. A, *Contemporary Optics for Scientists and engineers*, Prentice Hall, New Delhi, (1976).
6. Laud B. B, *Lasers and Non Linear Optics*, Wiley Eastern Limited, New Delhi,(1985).

Bloom's Taxonomy	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
K1: Remembering	**1**	**1**			
K2: Understanding		**2**			
K3: Applying	**3**		**3**		**3**
K4: Analyzing				**4**	
K5: Evaluating			**5**	**5**	
K6: Creating					
Mean					

PGP/PSP 5442 **PROJECT – II** **9 hrs/4 cr**

This course enables the Students to have hands-on experience in the design experiments / methodologies and record the process of measurements. He will also learn to correlate with the respective theoretical concepts and draw non-trivial conclusions of the significance of the observations.

At the end of the course, students will be able to

i. define problems, formulate hypotheses, test hypotheses, analyse, interpret and draw conclusions from data;
ii. identify relevant assumptions or implications; formulate coherent arguments;
iii. act together as a group or a team in the interests of a common cause and work efficiently as a member of a team;
iv. use ICT and demonstrate ability to access, evaluate, and use a variety of relevant information sources;

v. communicate with others using appropriate media; confidently share one's views and express herself/himself.

Students are given the freedom of choosing the topic of the project and approved by the staff supervisor/ guide. It may be theoretical or experimental. After getting approval of the proposed project work within 5 sessions, students are supposed to carry out these projects in the department laboratory. Students shall maintain daily records and present at least two oral progress reports while doing the project. They shall submit the dissertation at the end of the semester. Students are encouraged to have hands-on experience in designing, fabricating, and analyzing the observations using fundamental concepts studied in the course of study.

Evaluation Method for Project:

1. Project Proposal (Oral and written) 20%
2. Oral progress reports 20%
3. Continuous assessment 35%
4. Final Report 25%

Bloom's Taxonomy	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
K1: Remembering	**1**				
K2: Understanding	**2**				
K3: Applying	**3**		**3**	**3**	
K4: Analyzing	**4**	**4**		**4**	
K5: Evaluating	**5**				**5**
K6: Creating	6				
Mean					