PG and Research Department of Physics
Programme Specific Outcomes (PSOs)

On the successful completion of the Postgraduate programme, the students will be able to

PSO1 **Disciplinary Knowledge**	interpret and exhibit professional skills on fundamental interactions at quantum to astronomical scales.
PSO2 **Communication Skills**	develop communication skills, both written and oral for specialized and general audience.
PSO 3 **Problem Solving & Analytical Reasoning**	inculcate the problem solving ability in physics and interpret through analytical reasoning.
PSO 4 **Critical Thinking**	enhance the ability of critical thinking by applying appropriate methodology to solve a wide range of problems in Physics.
PSO 5 **Research Skills**	design and execute mini projects to experience the features of research and to provide lucid summation of the scientific literature on a chosen topic.
PSO 6 **Digital Literacy**	imbibe fundamental and advanced knowledge in physics through e-resources and to handle the computational tools and scientific software.
PSO 7 **Professional competencies**	enhance and adopt new skills through effective team work and novel thinking for future employability in teaching and research.
PSO 8 **Moral and Ethical Awareness/Reasoning**	practice the moral and ethical principles and responsibilities as a physicist in-order to serve the society and nation.
PSO 9 **Multicultural Competence**	exhibit the relevant generic skills of independent investigations and global competencies for physics-related issues.
PSO 10 **Self-directed & Lifelong Learning**	extend an independent and lifelong learning interest in the field of Physics.

PG and Research Department of Physics
Learning Outcomes-based Curriculum Framework (LOCF)
(w.e.f 2024-2025)

Sem	Category	Course Code	Course Title	Hours/Wk.	Credits	Marks
1	CC	24PGP/PSP4501	Classical Mechanics and Relativity	5	5	100
1	CC	24PGP/PSP4403	Mathematical Physics	4	4	80
1	CC	24PGP/PSP4405	Linear and Digital ICs and applications	4	4	80
1	CC	24PGP/PSP4407	Practical - I	9	4	80
1	DSE	24PGP/PSP43NN	*Discipline Specific Elective 1*	4	3	60
1	GE	24XXX43NN	*Generic Elective Course 1*	4	3	60
	Total			**30**	**23**	**460**
2	CC	24PGP/PSP4502	Quantum Mechanics – I	5	5	100
2	CC	24PGP/PSP4404	Advanced Mathematical Physics	4	4	80
2	CC	24PGP/PSP4406	Statistical Mechanics	4	4	80
2	CC	24PGP/PSP4408	Practical - II	9	4	80
2	DSE	24PGP/PSP43NN	*Discipline Specific Elective 2*	4	3	60
2	GE	24XXX43NN	*Generic Elective Course 2*	4	3	60
	Total			**30**	**23**	**460**

* Internship - First Year Vacation (30 Hrs.)

Discipline Specific Elective (DSE)

Sem	Category	Course Code	Course Title	Hours/Wk.	Credits	Marks
1	DSE	24PGP/PSP4321/ 24PGP/PSP4323	Energy Physics / Bio Physics	4	3	60
2	DSE	24PGP/PSP4322/ 24PGP/PSP4324	Physics of Nanoscience and Technology / Crystal Growth and Thin films	4	3	60

Generic Elective (GE)

Sem	Category	Course Code	Course Title	Hours/Wk.	Credits	Marks
1	GE	24PGP/PSP4311/ 24PGP/PSP4313	Observational Astronomy / Physics of Home Appliances	4	3	60
2	GE	24PGP/PSP4312/ 24PGP/PSP4314	Physics in Human Physiology/ Sustainable Energy Resources	4	3	60

Mapping with POs

PGP/PSP	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
	3	2	3	3	3	3	3	2	2	2

Mapping of Courses with PSOs

Courses	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PSO 9	PSO 10
24PGP/PSP4501	3	2	3	3	2	3	2	2	2	2
24PGP/PSP4403	3	3	3	2	3	3	3	3	2	2
24PGP/PSP4405	3	3	3	3	2	2	3	3	2	2
24PGP/PSP4407	3	2	3	3	3	3	3	2	2	2
24PGP/PSP4321/ 24PGP/PSP4323	3	2	3	3	3	3	3	2	2	2
24PGP/PSP4502	3	2	3	3	3	2	3	2	2	3
24PGP/PSP4404	3	3	3	2	3	3	3	3	2	2
24PGP/PSP4406	3	2	3	3	2	3	3	3	2	3
24PGP/PSP4408	3	2	3	3	3	3	3	2	3	3
24PGP/PSP4322/ 24PGP/PSP4324	3	2	3	3	3	3	3	2	3	3
24PGP/PSP5401	3	2	3	3	2	3	2	2	2	2
24PGP/PSP5403	3	2	2	2	2	1	1	1	2	2
24PGP/PSP5405	3	2	3	3	3	2	2	1	2	2
24PGP/PSP5307	3	2	3	3	3	3	2	2	2	2
24PGP/PSP5209	3	2	3	3	3	3	3	2	2	2
24PGP/PSP5211	3	2	3	3	3	2	3	3	2	2
24PGP/PSP5321/ 24PGP/PSP5323	3	2	3	3	3	2	3	3	2	2
24PGP/PSP5233	2	2	2	3	2	3	3	3	2	2
24PGP/PSP5402	3	2	3	3	2	3	2	3	2	2
24PGP/PSP5404	3	2	2	3	3	2	3	2	2	2
24PGP/PSP5406	3	2	3	3	3	3	3	2	2	2
24PGP/PSP5308	3	2	3	3	3	3	3	2	2	2
24PGP/PSP5210	3	2	3	3	3	3	3	2	2	2
24PGP/PSP5212	2	2	2	3	2	2	2	3	2	2
24PGP/PSP5322/ 24PGP/PSP5324	2	2	2	3	2	2	2	3	2	2
24PGP/PSP5244	3	3	3	3	3	2	3	3	2	2
Average	2.9	2	2.8	2.9	2.7	2.6	2.7	2.3	2	2.2

Mapping of Courses with POs

Courses	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
24PGP/PSP4311/ 24PGP/PSP4313	3	3	3	3	2	3	3	2	2	2
24PGP/PSP4312/ 24PGP/PSP4314	3	2	3	3	3	2	2	2	2	2
Average	3	2.5	3	3	2.5	2.5	2.5	2	2	2

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PGP/PSP4501	**Classical Mechanics and Relativity**	**Core**	**5**	**5**

This course interprets the generalized coordinates and employ the Lagrangian and Hamiltonian formulation for physical systems. Alsoit helps to analyze the normal modes of oscillations and dynamics of rigid body using Euler's equations of motion.

Course Outcomes:
At the end of the course, students will be able to
CO1: relate the fundamentals of classical mechanics in physical systems.
CO2: apply the principles of Lagrangian to solve the equations of motion of physical systems.
CO3: interpret the principles of Hamiltonian mechanics to solve the equations of motion of physical systems.
CO4: analyze the small oscillations in systems to determine their normal modes of oscillations.
CO5: use and apply the principles of relativistic kinematics to the mechanical systems
to solve rigid body problems using Euler's equation of motion.

Unit I: PRINCIPLES OF CLASSICAL MECHANICS (15 Hours)
Mechanics of a single particle – Mechanics of a system of particles – Conservation theorems - Conservation laws for a system of particles – Constraints – Holonomic & non-holonomic constraints – Generalized coordinates – Configuration space – Transformation equations – Variationalprinciple and its applications.

Unit II: LAGRANGIAN FORMULATION (15 Hours)
Principle of virtual work - D'Alembert's principle – Lagrangian equations of motion for conservative systems – Applications: (i) simple pendulum (ii) Atwood's machine (iii) projectile motion (iv) Compound Pendulum– Lagrangian equations of motion for Non conservative Forces – Velocity dependent potential and the dissipation function.

Unit III: HAMILTONIAN FORMULATION (15 Hours)
Phase space – Cyclic coordinates – Conjugate momentum – Hamiltonian function – Jacobi's integral – Hamilton's canonical equations of motion – Applications: (i) simple pendulum (ii) one dimensional simple harmonic oscillator (iii) motion of particle in a central force field –

Canonical transformation - Poisson's Brackets – Lagrange Brackets.

Unit IV: SMALL OSCILLATIONS (15 Hours)

Formulation of the problem – Potential Energy and equilibrium – Eigenvalue equation and the principal axis transformation – Transformation to normal coordinates – frequencies of normal modes – Examples -Two coupled oscillator and linear triatomic molecule.

Unit V: RELATIVITY (15 Hours)

Inertial and non-inertial frames – Lorentz transformation equations – Length contraction and time dilation – Relativistic addition of velocities – Einstein's mass-energy relation – Minkowski's space – Four vectors – Position, velocity, momentum, acceleration and force in four vector notation and their transformations.

Learning Resources:

Text Books

1. H. Goldstein, *Classical Mechanics*, Pearson Edition,3rd Edition, 2002.
2. J. C. Upadhyaya, *Classical Mechanics*, Himalaya Publishing. Co. New Delhi, 1stEdition, 2014.
3. R. Resnick, *Introduction to Special Theory of Relativity,* Wiley Eastern, New Delhi,1968.
4. R. G. Takwala and P.S. Puranik, *Introduction to Classical Mechanics* – Tata – McGraw Hill, New Delhi, 1980.
5. N. C. Rana and P.S. Joag, *Classical Mechanics* – Tata McGraw Hill, 2001.

References

1. K. R. Symon, *Mechanics*, Addison Wesley, London, 1971.
2. S. N. Biswas, *Classical Mechanics*, Books & Allied, Kolkata, 1999.
3. Gupta and Kumar, *Classical Mechanics*, Kedar Nath.,13thEdition, 2019.
4. T.W.B. Kibble, *Classical Mechanics*, ELBS., 5thEdition, 2004.
5. Greenwood, *Classical Dynamics*, PHI, New Delhi.2ndEdition,1988.

Websites/ e-Learning Resources

1. http://poincare.matf.bg.ac.rs/~zarkom/Book_Mechanics_Goldstein_Classical_Mechanics_optimized.pdf
2. https://pdfcoffee.com/classical-mechanics-j-c-upadhyay-2014-editionpdf-pdf-free.html
3. https://nptel.ac.in/courses/122/106/122106027/
4. https://ocw.mit.edu/courses/physics/8-09-classical-mechanics-iii-fall-2014/lecture-notes/
5. https://www.britannica.com/science/relativistic-mechanics

CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO 1	3	2	3	3	3	3	3	2	3	3
CO 2	3	2	3	3	3	3	2	3	2	2

CO 3	3	3	3	3	1	3	3	2	3	1
CO 4	3	2	3	3	1	1	2	3	1	2
CO 5	3	2	3	3	1	3	2	2	2	2
Average	3	2.2	3	3	2	3	2.4	2.4	2.2	2

Strong – 3 Medium – 2 Low – 1

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PGP/PSP4403	**Mathematical Physics**	**Core**	**4**	**4**

This course helps to understand the linear vector space, complex variables and matrices. They will acquire knowledge about special functions and series solutions of differential equations in physics. Students get basic concept about Fourier series and integral transforms and familiarize themselves with the importance and uniqueness of mathematical tools to analyze physics phenomenon.

Course Outcomes:

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

CO1: explain the properties of linear vector space understand the uses of bra-ket vector notation and apply them to physical models.

CO2:interpret analytic functions and complex integration, by applying Cauchy Integral formula and evaluate residues and definite integrals.

CO3: analyze characteristics of matrices and its different types,the process of diagonalization and a broad range of physical models.

CO4: analyze the Fourier transformations of different function, grasp how these transformations can speed up analysis and correlate their importance in technology and solve equations using Laplace transform.

CO5: find the solutions for physical problems using linear differential equations and to solve boundary value problems using Green's functions and special functions in computation of solutions to real world problems.

Unit I: LINEAR VECTOR SPACE (12 Hours)

Basic concepts – Definitions- Examples of vector space – Linear independence, basis - Scalar product- Orthogonality – Orthonormal basis - Gram-Schmidt orthogonalization procedure – Linear operators – Orthogonal basis – Change of basis –Orthogonal transformations and rotation.

Unit II: COMPLEX ANALYSIS (12 Hours)

Review of Complex Numbers -de Moivre's theorem-Functions of a Complex Variable-Differentiability -Analytic functions- Harmonic functions-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 and applications.

Unit III: MATRICES (12 Hours)

Types of Matrices and their properties, Special matrices - Hermitian and Unitary Matrices -

Transformation of matrices - Eigenvalues and Eigenvectors - Cayley–Hamilton theorem – Diagonalization– Coordinate transformations – Curvilinear coordinates – Jacobian coordinate transformations.

Unit IV: FOURIER TRANSFORMS & LAPLACE TRANSFORMS (12 Hours)

Definitions -Fourier transform and its inverse - Transform of Gaussian function and Dirac delta function - Cosine and sine transforms – Properties of Fourier transform - Convolution theorem - Parseval's relation - Fourier transform of derivatives – Fast Fourier transform.

Laplace transform and its inverse - Transforms of derivatives and integrals –Dirac delta functions – Applications.

Unit V: DIFFERENTIAL EQUATIONS (12 Hours)

Second order differential equation- Sturm-Liouville's theory - Series solution with simple examples - Hermite polynomials - Generating function - Orthogonality properties - Recurrence relations – Legendre polynomials - Generating function - Rodrigue formula – Orthogonality properties - Dirac delta function- One dimensional Green's function and its applications.

Learning Resources:

Text Books

1. Charlie Harper, *Introduction to Mathematical Physics*, Prentice-Hall, Inc. New Delhi, 6th Reprint, 1995.
2. George Arfken and Hans J Weber,*Mathematical Methods for Physicists – A Comprehensive Guide*, Academic press, Cambridge, Massachusetts, 7th Edition, 2012.
3. P.K. Chattopadhyay, *Mathematical Physics*, New Age, New Delhi,2nd Edition, 2013.
4. Louis A. Pipes and Lawrence R. Harvill, *Applied Mathematics for Engineers and Physicists*, McGraw-Hill International, 2014.

References

1. E. Kreyszig,*Advanced Engineering Mathematics*, Wiley Eastern, New Delhi, 3rd Edition, 1983.
2. D. G. Zill and M. R. Cullen,*Advanced Engineering Mathematics*, Narosa, New Delhi, 2006.
3. S. Lipschutz, *Linear Algebra, Schaum's Series*, McGraw - Hill, New York, 1987.
4. E. Butkov, *Mathematical Physics* Addison - Wesley, Reading, Massachusetts, 1968.
5. P. R. Halmos, *Finite Dimensional Vector Spaces*, Affiliated East West, New Delhi, 2nd Edition, 1965.
6. C. R. Wylie and L. C. Barrett,*Advanced Engineering Mathematics*, McGraw-Hill International Edition, New York, 6th Edition,1995.
7. A W Joshi, *Matrices and Tensors in Physics*, New Age International Pvt. Ltd., India, 4th Edition (Paperback), 2017.
8. B. D. Gupta, *Mathematical Physics*, Vikas Publishing House, New Delhi, 4thEdition, 2009.
9. H. K. Dass and Dr. Rama Verma, *Mathematical Physics*, S. Chand & Company Pvt. Ltd., New Delhi, 7th Revised Edition, 2014.

Websites/ e-Learning Resources

1. www.khanacademy.org

2. https://youtu.be/LZnRlOA1_2I
3. http://hyperphysics.phy-astr.gsu.edu/hbase/hmat.html#hmath
4. https://www.youtube.com/watch?v=_2jymuM7OUU&list=PLhkiT_RYTEU27vS_SlED56gNjVJGO2qaZ
5. https://archive.nptel.ac.in/courses/115/106/115106086/

CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO 1	3	3	3	2	2	3	2	3	2	2
CO 2	3	3	2	2	3	3	2	3	3	2
CO 3	3	3	3	2	2	3	3	3	3	2
CO 4	3	3	3	3	3	3	3	3	2	3
CO 5	3	2	3	3	3	3	3	3	2	3
Average	3	2.8	2.8	2.4	2.6	3	2.6	3	2.4	2.4

Strong – 3 Medium – 2 Low – 1

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PGP/PSP4405	**Linear and Digital ICs and Applications**	**Core**	**4**	**4**

This course gives an introductory knowledge about the basic building blocks of linear integrated circuits, theory and applications of Phase Locked Loop (PLL) and concepts of waveform generation and an exposure to digital IC's.

Course Outcomes:

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

CO1: learn about the basic concepts for the circuit configuration for the design of linear integrated circuits and develops skill to solve problems.

CO2: develop skills to design linear and non-linear applications circuits using Op-Amp and design the active filters circuits.

CO3: gain knowledge about Phase Locked Loop, and develop the skills to design the simple circuits using IC 555 timer and can solve problems related to it.

CO4: learn about various techniques to develop A/D and D/A converters.

CO5: acquire the knowledge about the CMOS logic, combinational and sequential circuits.

Unit I: INTEGRATED CIRCUITS AND OPERATIONAL AMPLIFIER (12 Hours)

Introduction - Classification of IC's - Basic information of Op-Amp 741 and its features - The ideal Operational amplifier - Op-Amp internal circuit and Op-Amp - Characteristics.

Unit II: APPLICATIONS OF OP-AMP (12 Hours)

Linear applications of Op-Amp: Solution to simultaneous equations and differential equations - Instrumentation amplifiers - V to I and I to V converters - Non-linear applications of Op-Amp: Sample and Hold circuit - Log and Antilog amplifier -Multiplier and Divider – Comparators - Schmitt trigger -Multivibrators -Triangular and Square waveform generators.

Unit III: ACTIVE FILTERS & TIMER AND PHASE LOCKED LOOPS (12 Hours)

Active Filters: Introduction -Butterworth filters – 1st order, 2nd order low pass and high pass filters, band pass, band reject and all pass filters -Timer And Phase Locked Loops: Introduction

to IC 555 timer - Description of functional diagram -Monostable and astable operations and applications - Schmitt trigger -Phase Locked Loop:Introduction B basic principle -Phase detector/comparator -Voltage controlled oscillator (IC 566) -Low pass filter -Monolithic Phase Locked Loop and applications of Phase Locked Loop.

Unit IV: VOLTAGE REGULATOR, D TO A AND A TO D CONVERTERS (12 Hours)

Voltage Regulator: Introduction - Series Op-Amp regulator - IC Voltage Regulators - IC 723 general purpose regulators - Switching regulator -D to A and A to D Converters: Introduction - Basic DAC techniques -Weighted resistor DAC - R-2R ladder DAC -Inverted R-2R DAC - A to D converters -Parallel comparator type ADC - Counter type ADC - Successive approximation ADC and dual slope ADC - DAC and ADC specifications.

Unit V: CMOS LOGIC, COMBINATIONAL CIRCUITS USING TTL 74XX ICs AND SEQUENTIAL CIRCUITS USING TTL 74XX ICs (12 Hours)

CMOS Logic: CMOS logic levels - MOS transistors - Basic CMOS Inverter - NAND and NOR gates - CMOS AND-OR-INVERT and OR-AND-INVERT gates -Implementation of any function using CMOS logic -Combinational circuits using TTL 74XX ICs: Study of logic gates using 74XX ICs - Four-bit parallel adder (IC 7483) - Comparator (IC 7485) - Decoder (IC 74138, IC 74154) - BCD to 7-segment decoder (IC7447) - Encoder (IC74147) - Multiplexer (IC74151) -Demultiplexer (IC 74154) -Sequential Circuits using TTL 74XX ICs: Flip Flops (IC 7474, IC 7473) - Shift Registers - Universal Shift Register (IC 74194) - 4- bit asynchronous binary counter (IC 7493).

Learning Resources:

Text Books

1. D. Roy Choudhury, Shail B. Jain, *Linear Integrated Circuit*, New Age International Pvt. Ltd., New Delhi, India, 4th Edition, 2012.
2. Ramakant A. Gayakwad, *OP-AMP and Linear Integrated Circuits*, Prentice Hall / Pearson Education, New Delhi, 4th Edition, 2012.
3. B.L. Theraja and A.K. Theraja, *A Textbook of Electrical technology*, S. Chand &Co., 2004.
4. V.K. Mehta and Rohit Mehta, *Principles of Electronics*, S. Chand & Co, 12th Edition, 2008.
5. V. Vijayendran, *Introduction to Integrated electronics (Digital & Analog)*, S. Viswanathan Printers & Publishers Private Ltd, Reprint. V, 2008.
6. Millman&Halkias, *Integrated Electronics*, Tata McGraw Hill, 2009.

References

1. Sergio Franco, *Design with operational amplifiers and analog integrated circuits*, McGraw Hill, New Delhi, 1997.
2. Gray, Meyer, *Analysis and Design of Analog Integrated Circuits*, Wiley International, New Delhi, 5th Edition, 1995.
3. Malvino and Leach ,*Digital Principles and Applications*, Tata McGraw Hill, New Delhi, 2005.
4. Floyd, Jain, *Digital Fundamentals*, Pearson Education, New Delhi, 8th Edition, 2002.

Websites/e-Learning Resources

1. https://nptel.ac.in/course.html/digital circuits/
2. https://nptel.ac.in/course.html/electronics/operational amplifier/
3. https://www.allaboutcircuits.com/textbook/semiconductors/chpt-7/field-effect-controlled-thyristors/
4. https://www.electrical4u.com/applications-of-op-amp/
5. https://www.geeksforgeeks.org/digital-electronics-logic-design-tutorials/

CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO 1	3	3	3	3	3	2	3	3	3	3
CO 2	3	3	3	3	3	3	3	3	3	2
CO 3	3	2	3	3	2	3	3	3	2	2
CO 4	3	3	3	3	2	3	3	3	2	1
CO 5	3	2	3	2	2	1	2	3	2	2
Average	3	2.6	3	2.8	2.4	2.4	2.8	3	2.4	2

Strong – 3 Medium – 2 Low – 1

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PGP/PSP4407	**Practical - I**	**Core**	**9**	**4**

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.

Course Outcomes:

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

CO1:practice systematic laboratory work habits.
CO2:design experiments and verify theoretical concepts.
CO3:perform data and error analysis.
CO4:handle advanced equipment in the lab.
CO5:troubleshoot physics experiments.

List of Experiments

(Any 16 Experiments inclusive of electronics, non electronics, computer programming and microcontroller)

1. Fabrication of a dual power supply and study its voltage regulation.
2. Familiarization of CRO and signal generators.
3. Work shop practice – Use of tools and machines.
4. Familiarization of Excel calculations, graph and PCB making software.
5. Determination of Young's modulus and Poisson's ratio by hyperbolic fringes - Cornu's Method.
6. Measurement of Susceptibility of liquid usingQuincke's method.
7. Determination of Viscosity of the given liquid by using Meyer's disc.
8. Measurement of Coefficient of linear expansion by Air wedge Method.
9. Analyzing B-H loop using Anchor ring.
10. Determination of Rydberg's Constant for Hydrogen Spectrum.
11. Calibration of CDS using Na Lamp, Hg spectrum, and determination of spacing between FabryPerot etalon.
12. Determination of thickness of air film using Edser and Butler fringes.
13. Measurement of Band gap energy for Thermistor, diode and LED.

14. Determination of Specific charge of an electron using Thomson's method.
15. Determination of Molecular spectra using AlO band, CN bands.
16. Measurement of wavelength of Diode Laser / He – Ne Laser using Diffraction grating.
17. Study the beam divergence, spot size and intensity profile of Diode/He-Ne laser.
18. Determination and verification of standing wave, standing wave co-efficient, law of Inverse square, receiver end transmitter behaviour and radiation pattern using microwave test bench.
19. Verification of Beer-Lambert's law and identification of wavelength maxima and Extinction coefficient by using UV-Visible spectroscopy.
20. Studying circular and elliptical polarization using Linear polarizer & Quarter wave plate.
21. Eddy current – Electromagnet & mapping the magnetic field.
22. Determination of refractive index of glass, and liquids, sugar content using Laser pointer.
23. Analyzing periodic function by using Fourier series experiment.
24. Calculating the Age of universe using spectrum and galaxy diagram.
25. Determining the thickness of mica sheet using channeled spectrum.
26. Construction of relaxation oscillator using UJT.
27. Studying the characteristics of FET (V_p, I_{DSS}, g_m, r_d).
28. Study of attenuation characteristics of Wien's bridge and phase shift network and design of Wien's bridge and phase shift oscillator using Op-Amp.
29. Construction of Schmitt triggers circuit using IC 741 for a given hysteresis- application as squarer.
30. Construction of a quadrature wave using IC 324.
31. Construction of pulse generator using the IC 741 – application as frequency divider.
32. Study of R-S, clocked R-S and D-Flip flop using NAND gates.
33. Study of J-K, D and T flip flops using IC 7476/7473.
34. Study of Arithmetic logic unit using IC 74181.
35. Construction of Encoder and Decoder circuits using ICs.
36. Study of AC circuits – RC, RL, and LCR – using CRO.
37. Data logging using Lab View software.
38. Study of charging and discharging of a capacitor.
39. Construction of active filters using Op-Amp (Low pass, High pass and Band pass filters (Second Order) Butterworth filter).
40. Construction of Multiplexer and Demultiplexer using ICs.
41. Lagrange interpolation with Algorithm, Flow chart and output.
42. Newton forward interpolation with Algorithm, Flow chart and output.
43. Newton backward interpolation with Algorithm, Flow chart and output.
44. Curve-fitting: Least squares fitting with Algorithm, Flow chart and output.
45. Numerical integration by the trapezoidal rule with Algorithm, Flow chart and output.
46. Numerical integration by Simpson's rule with Algorithm, Flow chart and output.
47. 8-bit addition and subtraction, multiplication and division using 8085.
48. Sum of a set of N data (8-bit number), picking up the smallest and largest number in an array. Sorting in ascending and descending order – 8085.
49. Code conversion (8-bit number): a) Binary to BCD b) BCD to binary.
50. Addition of multi byte numbers, Factorial using 8085 Microprocessor.
51. Clock program- 12/24 hours-Real time application – Six Digits Hexa Decimal and Decimal Counters using 8085 Microprocessor.
52. Interfacing of LED, Binary up/down counter, BCD up/down counter and N/2N up/down

counter using 8085.

53. Interfacing of seven segment display using Microcontroller 8051.
54. Interfacing of 8-bit R / 2R ladder DAC (IC 741) , Square, Rectangular, Triangular, Saw tooth and Sine using Microcontroller 8051.
55. DAC 0800/ DAC 1048 interface and wave form generation (Unipolar/ Bipolar output) using Microcontroller 8051.
56. ADC 0809 interface using Microcontroller 8051.

Learning Resources:

Text Books

1. Gupta and Kumar, *Practical Physics*, PragatiPrakasan Publisher, 2018.
2. R.Srinivasan K.R Priolkar, *Kit Developed for doing experiments in Physics- Instruction manual*, Indian Academy of Sciences, 2018.
3. S.Poornachandra, B.Sasikala, *Electronic Laboratory Primer a design approach*, Wheeler Publishing, New Delhi, 2005.
4. K. A. Navas, *Electronic lab manual Vol I*, Rajath Publishing, 2015.
5. K. A. Navas, *Electronic lab manual Vol II*, PHI eastern Economy Edition, 2018.

References

1. S.P Singh,*Advanced Practical Physics*, PragatiPrakasan Publisher, 2019.
2. D.Chattopadhayay, C.R Rakshit, *An Advanced Course in Practical Physics*, New Central Book Agency Pvt. Ltd, 1990.
3. Ramakanth A Gaykwad, *Op-Amp and linear integrated circuit*, Eastern Economy Edition, 2000.
4. R.S. Sirohi, *A course on experiment with He-Ne Laser*, John Wiley & Sons (Asia) Pvt. Ltd., 1989.
5. Kuriachan T.D, *Syam Mohan, Electronic lab manual Vol II*, Ayodhya Publishing., 2018.

CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO 1	2	2	2	3	2	2	2	1	2	3
CO 2	2	2	3	3	3	3	3	3	3	3
CO 3	3	3	3	3	3	3	3	3	3	1
CO 4	3	2	3	3	3	3	3	3	2	2
CO 5	3	3	3	3	3	3	2	2	2	2
Average	2.6	2.4	2.8	3	2.8	2.8	2.6	2.4	2.4	2.2

Strong – 3 Medium – 2 Low – 1

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PGP/PSP4321	**Energy Physics**	**DSE**	**4**	**3**

This course intends to provide knowledge of conventional energy resources, to learn about various renewable energy sources, to know the ways of effectively utilizing the oceanic energy, to study the method of harnessing wind energy and its advantages, to learn the techniques useful for the conversion of biomass into useful energy, to know about utilization of solar energy.

Course Outcomes:

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

CO1: identify various forms of renewable and non-renewable energy sources

CO2: explain the principle of utilizing the oceanic energy and apply it for practical applications.

CO3: demonstrate the working of a windmill and analyze the advantages of wind energy.

CO4: distinguish aerobic digestion process from anaerobic digestion

CO5: estimate the components of solar radiation, their measurement and apply them to utilize solar energy.

Unit I: INTRODUCTION TO ENERGY SOURCES (12 Hours)

Conventional and non-conventional energy sources and their availability – Prospects of Renewable energy sources – Energy from other sources – Chemical energy – Nuclear energy– Energy storage and distribution.

Unit II: ENERGY FROM THE OCEANS (12 Hours)

Energy utilization–Energy from tides–Basic principle of tidal power–Utilization of tidal energy – Principle of ocean thermal energy conversion systems.

Unit III: WIND ENERGY SOURCES (12 Hours)

Basic principles of wind energy conversion – Power in the wind – forces in the Blades – Wind energy conversion–Advantages and disadvantages of wind energy conversion systems (WECS) - Energy storage–Applications of wind energy.

Unit IV: ENERGY FROM BIOMASS (12 Hours)

Biomass conversion Technologies– Wet and dry process– Photosynthesis -Biogas Generation: Introduction–basic process: Aerobic and anaerobic digestion – Advantages of anaerobic digestion – Factors affecting bio digestion and generation of gas- Bio gas from waste fuel– Properties of biogas-Utilization of biogas.

Unit V: SOLAR ENERGY SOURCES (12 Hours)

Solar radiation and its measurements–Solar cells: Solar cells for direct conversion of solar energy to electric powers–Solar cell parameter–Solar cell electrical characteristics– Efficiency– Solar water Heater –Solar distillation– Solar cooking–Solar greenhouse – Solar Pond and its applications.

Learning Resources:

Text Books

1. G.D. Rai, *Non – conventional sources of Energy*, Khanna publishers, New Delhi, 4th Edition, 1996.
2. M.P. Agarwal, *Solar Energy*, S. Chand and Co., New Delhi, 1983.
3. S. P. Sukhatme, *Solar Energy, Principles of Thermal Collection and Storage*, Tata McGraw - Hill Publishing Co. Lt., New Delhi,2nd edition, 1997.
4. S Rao and Dr. Parulekar, *Energy Technology (Non Conventional, Renewable and Conventional)*, Khanna Publisher, 1994.

Reference Books

1. John Twidell and Tonyweir, *Renewable energy resources*, Taylor and Francis group, London and New York, 2015.
2. B. Meinel and A. P. Meinal, *Applied solar energy: An Introduction*, NASA STI/Recon Technical Report A, 1977.
3. C.S. Solanki, *Renewal Energy Technologies: A Practical Guide for Beginners*, PHI Learning, 2008.
4. Raja et. al., *Introduction to Non-Conventional Energy Resources*, Sci. Tech Publications, 2015.

Websites/ e-Learning Resources

1. https://www.open.edu/openlearn/ocw/mod/oucontent/view.php?id=2411&printable=1
2. https://www.nationalgeographic.org/encyclopedia/tidal-energy/
3. https://www.ge.com/renewableenergy/wind-energy/what-is-wind-energy
4. https://www.reenergyholdings.com/renewable-energy/what-is-biomass/
5. https://www.acciona.com/renewable-energy/solar-energy/

CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO 1	2	3	3	3	3	3	2	2	3	3

CO 2	3	2	3	3	3	2	3	3	3	3
CO 3	3	2	3	3	3	3	3	2	2	2
CO 4	2	3	2	3	2	3	2	1	2	2
CO 5	3	2	3	3	3	3	2	3	2	3
Average	2.8	2.4	2.8	3	2.8	2.8	2.4	2.2	2.4	2.6

Strong – 3 Medium – 2 Low – 1

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PGP/PSP4323	**Bio Physics**	**DSE**	**4**	**3**

This course intends to provide the fundamental concepts of Physics and Biology, to understand the physical principles, to understand the physical principles involved in cell function maintenance, to understand the fundamentals of macromolecular structures involved in propagation of life, to understand the biophysical function of membrane and neuron, to understand various kinds of radiation and their effects on living system and to know the hazards posed by such radiations and the required precautions, to understand the physical principles behind the various techniques available for interrogating biological macromolecules.

Course Outcomes:

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

CO1: relate the structural organization and function of living cells and should able to apply the cell signaling mechanism and its electrical activities.

CO2: discuss the role of biomolecular conformation to function.

CO3:sketch the function of biological membranes and also to understand the functioning of nervous system.

CO4: compare the effects of various radiations on living systems and how to prevent ill effects of radiations.

CO5:interpret the various techniques viz., spectroscopy, crystallography, chromatography.

Unit I: CELLULAR BIOPHYSICS (12 Hours)

Architecture and life cycle of cells – Organelles of Prokaryotic and Eukaryotic cell – Cell size and shape – Fine structure of Prokaryotic and Eukaryotic cell organization – Compartment & assemblies membrane system – Extracellular matrix - Molecular mechanisms of Vesicular traffic - Electrical activities of cardiac and neuronal cells

Unit II: MOLECULAR BIOPHYSICS (12 Hours)

Macromolecular structure: Protein structure – Amino acids, peptide bonds, primary, secondary,

tertiary and quaternary structures of proteins-Nucleic acid structure: nucleosides and nucleotides, RNA structure, DNA structure and conformation-Special Bio-macromolecules: Metalloproteins, nucleoproteins, ribozymes, chaperons and prions.

Unit III: MEMBRANE AND NEURO BIOPHYSICS (12 Hours)

Membranes - Biological membranes and dynamics – Membrane Capacitors – Transport across cell and organelle membranes – Ion channels.

Nervous system: Organization of the nervous system –Membrane potential – Origins of membrane potential - Electrochemical potentials – Nernst equation – Goldman equation.

Unit IV: RADIATION BIO PHYSICS (12 Hours)

X-Ray: Effects on bio-macromolecules – Gamma Radiation: Molecular effects of gamma radiation, Radiation effects on nucleic acids and membranes, Effects on cell and organelles – UV radiation: Effects on bio-macromolecules and proteins – Radiation hazards and protection – use of radiations in cancer.

Unit V: PHYSICAL METHODS IN BIOLOGY (12 Hours)

Spectroscopy: UV-Visible absorption spectrophotometry – Optical Rotatory Dispersion (ORD) – Structure Determination: X-ray Crystallography, Electron spin resonance (ESR) and biological applications. Chromatography: Thin layer chromatography (TLC), Gas liquid chromatography (GLC) – Centrifugation: Differential centrifugation, density gradient centrifugation. Electrophoresis: Gel electrophoresis, polyacrylamide gel electrophoresis.

Learning Resources:

Text Books

1. Geoffrey M. Cooper, *The cell: A molecular approach*, ASM Press, 2013.
2. VasanthaPattabhi, N. Gautham, *Biophysics*, Narosa Publishing, 2009.
3. P. S. Mishra, *Biophysics*, VK Enterprises, 2010.
4. M. A Subramanian, *Biophysics*, MJP Publishers, 2005.
5. L. Veerakumari, *Bioinstrumentation*, MJP Publishers, 2006.

Reference Books

1. Daniel A Beard, *Chemical Biophysics*, Cambridge University Press, 2008.
2. Bruce Albert et al., *Essential cell biology*, Garland Science Publisher, 2015.
3. W. Hoppe, W. Lohmann, H. Markl and H. Ziegler, *Biophysics*, Springer Verlag, Berlin 1983.
4. Mohammad Ashrafuzzaman, Jack A. Tuszynski, *Membrane Biophysics*, Springer science & business media, 2012.
5. Iain D. Campbell, Raymond A. Dwek, *Biological spectroscopy*, Menlo Park, Calif., 1984.

Websites/ e-Learning Resources

1. http://www.cis.rit.edu/htbooks/nmr/inside.htm
2. http://learn.genetics.utah.edu/content/labs/gel/
3. http://mw.concord.org/modeler/
4. https://blanco.biomol.uci.edu/WWWResources.html

CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO 1	3	3	3	3	2	3	2	2	2	3
CO 2	3	3	3	2	3	2	1	2	2	2
CO 3	3	3	3	3	2	1	2	2	2	2
CO 4	3	3	3	2	2	2	2	2	2	2
CO 5	3	1	3	3	2	2	3	2	2	2
Average	3	2.6	3	2.6	2.2	2	2	2	2	2.2

Strong – 3 Medium – 2 Low – 1

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PGP/PSP4311	**Observational Astronomy**	**GE**	**4**	**3**

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.

Course Outcomes:

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

CO1:summarize the birth of modern astronomy from ancient times.

CO2:compare the different types of telescopes.

CO3:categorize galaxies based on Hubble classification and distinguish various mysterious objects.

CO4:describe the theory of birth and evolution of stars.

CO5:explain different models of origin of universe.

Unit I: BIRTH OF MODERN ASTRONOMY (12 Hours)

Birth of modern astronomy –Compare and contrast the views of Plato and Aristotle– Kepler's Laws – Newtonian gravitation – Seasons – Eclipse – Solar, lunar - Solar family.

Unit II: TELESCOPES (12 Hours)

Astronomical observations – Optical telescopes – Reflecting – Refracting – Telescope mounts– Radio telescope– UV- IR- X-ray telescopes.

Unit III: STELLAR EVOLUTION (12 Hours)

Formation of a star from a cloud of interstellar matter- Birth of low mass stars like our sun, - Mainsequence star to a dead star- White dwarf - Neutron star - Inventory of the Solar System.

Unit IV:GALACTIC ASTRONOMY (12 Hours)

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

Unit V: ORIGIN OF UNIVERSE (12 Hours)

Cosmological principle – Hubble's law - The Big bang - Expansion of the Universe – Hubble's law – Steady state – Pulsating theory.

Learning Resources:

Text Books

1. Nigel Marshall, *GCSE Astronomy*, 4thEdition,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.

Websites/ e-Learning Resources

1. https://openstax.org/books/astronomy-2e/pages/2-4-the-birth-of-modern-astronomy
2. https://www.cliffsnotes.com/study-guides/astronomy/galaxies/galaxies-types-and-classifications
3. https://optcorp.com/blogs/telescopes-101/the-basic-telescope-types

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	3	3	3	3	2	3	3	3	3	2
CO 2	3	3	3	3	2	3	3	3	3	2
CO 3	3	2	3	3	2	3	3	3	2	2
CO 4	3	3	3	3	2	3	3	1	2	2
CO 5	3	3	3	3	2	3	3	2	2	2
Average	3	2.8	3	3	2	3	3	2.4	2.4	2

Strong – 3 Medium – 2 Low – 1

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PGP/PSP4313	Physics of Home Appliances	GE	4	3

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.

Course Outcome:
At the end of the course, students will be able to
CO1: explain the fundamentals of electricity and electronic components.
CO2: implement the skills of testing and servicing the basic equipment of the home appliances.
CO3:classify different domestic appliances and explain the physics of appliances.
CO4:ascertain the maintenance of domestic appliances.
CO5:explain the energy consumption of home appliances.

Unit I: INTRODUCTION TO ELECTRICITY AND ELECTRONICS(12 Hours)
Basic Electricity (Qualitative): Voltage, Current, Resistance, Impedance & Power factor - Transformers - Step-up & Step-down - Fuse, Concept of Earthing. Electronics: Familiarization of electronic components - Capacitor, Diode, Transistor. 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 (12 Hours)
Electric stove - Electric Rice cooker - Toaster - Kettle - Coffee maker -Iron box –Room heater -

Immersion heater - Geyser - Hair drier- Microwave oven.

Unit III: MOTORISED APPLIANCES (12 Hours)

Electric fans - Mixer - Grinder/Blenders –Washing machine - Vacuum cleaner - Domestic water pump - Dish washer.

Unit IV: REFRIGERATION APPLIANCES (12 Hours)

Refrigerator: Compressor - Coolants - Automatic defrost circuits - Air coolers - Air conditioners.

Unit V: OTHER APPLIANCES (12 Hours)

Lights: Incandescent Bulbs, Tube light, CFL bulb – LED. Voltage stabilizer - Inverters – UPS.

Learning Resources:

Text book

1. B.L. Theraja and 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. Shashi Bhushan Sinha, *Handbook of Repair and Maintenance of Domestic Electronics Appliances*, BPB Publications, India, 2016.

Websites/ e-Learning Resources

1. https://spark.iop.org/power-and-domestic-appliances
2. https://www.docbrown.info/ephysics/electricity1.htm

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	3	2	3	2	2	3	2	3	2	2
CO 2	3	2	3	2	2	3	2	2	2	2
CO 3	3	2	3	3	2	3	2	2	3	2
CO 4	3	2	3	3	2	3	2	3	2	2
CO 5	3	2	3	3	2	3	2	1	3	2
Average	3	2	3	2.6	2	3	2	2.2	2.4	2

Strong – 3 Medium – 2 Low – 1

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PGP/PSP4502	**Quantum Mechanics – I**	**Core**	**5**	**5**

This course deals with the basics of quantum mechanics, exactly solvable eigenvalue problems, approximation methods for solving Schrodinger equation and theory of angular momentum.

Course Outcomes:

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

CO1: demonstrate a clear understanding of the basic postulates of quantum mechanics which serve to formalize the rules of quantum Mechanics.

CO2: apply and analyze the Schrodinger equation to solve one dimensional problem and three dimensional problems.

CO3: discuss the various representations, space time symmetries and formulations of time evolution.

CO4: formulate and analyze the approximation methods for various quantum mechanical problems.

CO5: apply non-commutative algebra for topics such as angular and spin angular momentum and hence explain spectral line splitting.

Unit I: BASIC FORMALISM (15 Hours)

The Schrodinger equation: A free particle in one Dimension – Generalization to three dimensions – The operator correspondence and the Schrodinger Equation for a particle subject to forces, Physical Interpretation of the wave function and admissibilityconditions on Ψ - Normalization and probability interpretation – Non-normalizablewavefunctions and Box

normalization – Conservation of probability – Expectation values -Ehrenfest's Theorems.

Unit II: ONE DIMENSIONAL AND THREE-DIMENSIONAL ENERGY EIGENVALUE PROBLEMS (15 Hours)

Square well potential with rigid walls – Square well potential with finite walls – Multiple potential wells-Square potential barrier —Linear harmonic oscillator: Analytical method, Operator method – Particle moving in a spherically symmetric potential – System of two interacting particles – Hydrogen atom – Rigid rotator.

Unit III: GENERAL FORMALISM (15 Hours)

The Fundamental postulates of wave mechanics – The eigenvalue problem –Degeneracy-Dirac delta function-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 IV: APPROXIMATION METHODS (15 Hours)

Time independent perturbation theory for non-degenerate energy levels – Degenerate energy levels – Stark effect in Hydrogen atom – Ground and excited state – Variation method – Helium atom – WKB approximation – Connection formulae (no derivation) – WKB quantization.

Unit V: ANGULAR MOMENTUM (15 Hours)

Eigenvalue spectrum of general angular momentum – Ladder operators and their algebra – Matrix representation – Spin angular momentum – Addition of angular momenta – CG Coefficients – Symmetry and anti – symmetry of wave functions – Identical Particles with Spin-Construction of wave functions and Pauli's exclusion principle.

Learning Resources:

Text Books

1. P. M. Mathews and K. Venkatesan, *A Text book of Quantum Mechanics*, Tata McGraw-Hill, New Delhi,2nd Edition,2010.
2. G. Aruldhas, *Quantum Mechanics*, Prentice Hall of India, New Delhi, 2nd Edition, 2009.
3. David J Griffiths, *Introduction to Quantum Mechanics*, Pearson, 4th Edition, 2011.
4. SL Gupta and ID Gupta, *Advanced Quantum Theory and Fields*, S.Chand& Co., New Delhi, 1st Edition,1982.
5. A. Ghatak and S. Lokanathan, *Quantum Mechanics: Theory and Applications*, Macmillan, India, 4th Edition, 1984.

References

1. E. Merzbacher, *Quantum Mechanics*, John Wiley and Sons, New York, 2nd Edition, 1970.
2. V. K. Thankappan, *Quantum Mechanics*, Wiley Eastern Ltd, New Delhi,2nd Edition, 1985.
3. L. D. Landau and E. M. Lifshitz, *Quantum Mechanics*, Pergomon Press, Oxford, 1st Edition, 1976.
4. S. N. Biswas, *Quantum Mechanics*, Books and Allied Ltd., Kolkata, 1999.
5. V. Devanathan, *Quantum Mechanics*, Alpha Science International Ltd, Oxford , 2nd Edition,

2011.

Web/ e- Learning Resources

1. http://www.feynmanlectures.caltech.edu/III_20.html
2. http://web.mit.edu/8.05/handouts/jaffe1.pdf
3. https://hepwww.pp.rl.ac.uk/users/haywood/Group_Theory_Lectures/Lecture_1.pdf
4. https://theory.physics.manchester.ac.uk/~xian/qm/chapter3.pdf

CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO 1	3	3	3	3	3	2	3	2	2	3
CO 2	3	3	3	3	3	3	3	2	2	3
CO 3	2	3	3	2	3	2	3	2	2	3
CO 4	3	2	3	3	3	2	3	2	2	2
CO 5	3	1	3	2	3	2	2	2	2	2
Average	2.8	2.4	3	2.6	3	2.2	2.8	2	2	2.6

Strong – 3 Medium – 2 Low – 1

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PGP/PSP4404	**Advanced Mathematical Physics**	**Core**	**4**	**4**

This course equips the students with mathematical techniques needed for understanding theoretical treatment in different courses taught in their program, also to extend their manipulative skills to apply mathematical techniques in their fields and helps students to apply Mathematics in solving problems of Physics.

Course Outcomes:

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

CO1: gain knowledge of both discrete and continuous groups.

CO2: apply various important theorems in group theory.

CO3:constructgroup multiplication table, character table relevant to important branches of physics.

CO4: solve problems in tensors.

CO5: develop skills to apply group theory and tensors to peruse research.

Unit I: DISCRETE GROUPS (12 Hours)

Definition of a group, subgroup, class - Lagrange's theorem - Invariant subgroup - Homomorphism and isomorphism between two groups - Representation of a group, unitary representations, reducible and irreducible representations -Schur's lemmas - orthogonality theorem -Character table -Reduction of Kronecker product of representations - Criterion for irreducibility of a representation.

Unit II: CONTINUOUS GROUPS (12 Hours)

Infinitesimal generators - Lie algebra - Rotation group, representations of the Lie algebra of the rotation group, representation of the rotation group - D-matrices and their basic properties - Addition of two angular momenta and C.G. coefficients - Wigner-Eckart theorem.

Unit III: SPECIAL UNITARY GROUPS - PROBABILITY (12 Hours)

Definition of unitary -Unimodular groups SU (2) and SU(3) - Lie algebra of SU(2) – Probability -Permutations and combinations -Random variables and distributions -Binomial, Poisson and normal distributions -Experiments, sample and populations -Sample statistics, fitting curves to data - chi-square distribution and t distribution.

Unit IV: TENSORS (12 Hours)

Cartesian vectors and tensors with illustration– Four vector in special relativity - vectors and tensors under Lorentz transformations - Illustration from physics - Vectors and tensors under general co-ordinate transformations in linear space -Contravariant and covariant tensors - Mixed tensors -Tensor algebra -Quotient theorem -Symmetric and antisymmetric tensors.

Unit V: TENSOR CALCULUS (12 Hours)

Line element - Metric tensor -Covariant derivative - Expression for Christoffel symbols in terms of and its derivatives - Curvature tensor –Equation of the Geodesic line–Riemann-Christoffel tensor.

Learning Resources:

Text Books

1. A. W. Joshi, *Group Theory for Physicists*, New Age International Publishers, 2018.
2. E. Butkov, *Mathematical Physics*, Addison-Wesley Publishing Company, 1973.
3. Louis A. Pipes and Lawrence R. Harvill, *Applied Mathematics for Engineers and Physicists*, McGraw-Hill International, 2014.
4. Charlie Harper, *Introduction to Mathematical Physics*, Prentice-Hall, Inc, 1976.
5. D. B. Lichtenberg, *Unitary Symmetry and Elementary Particle*, Academic Press, 2013.
6. J. V. Narlikar, *General Relativity & Cosmology*, Macmillan Publisher, 1979.

References

1. M. Hamermesh, *Group Theory and Its Application to Physical Problems*, Dover Publications Inc., 2003.
2. M. E. Rose, *Elementary Theory of Angular Momentum*, Dover Publications Inc., 2003.
3. Georgi, Lie *Algebras in Particle Physics: from Isospin To Unified Theories*, Westview Press Inc., 1999.
4. E. A. Lord: *Tensors, Relativity & Cosmology*, Tata McGraw Hill Publishing Co Ltd., New Delhi, 1976.
5. P. Szekeres, *A Course in Modern Mathematical Physics: Groups*, Hilbert spaces and differential geometry, Cambridge University Press, 2004.

Websites/e-Learning Resources

1. https://vdoc.pub/documents/unitary-symmetry-and-elementary-particles-c4qsfejthkc0
2. https://physics.iith.ac.in/HEP_Physics/slides/poplawskitalk.pdf
3. https://www.hindawi.com/journals/amp/
4. https://projecteuclid.org/journals/advances-in-theoretical-and-mathematical-physics
5. https://www.springer.com/journal/11232

CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO 1	3	3	3	2	2	3	2	3	2	2
CO 2	3	2	2	2	3	3	2	3	3	2
CO 3	3	3	3	2	2	3	3	3	3	2
CO 4	3	2	3	3	3	3	3	3	2	3
CO 5	3	3	3	3	3	3	3	1	2	3
Average	3	2.6	2.8	2.4	2.6	3	2.6	2.6	2.4	2.4

Strong – 3 Medium – 2 Low – 1

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PGP/PSP4406	**Statistical Mechanics**	**Core**	**4**	**4**

This course enables learners to acquire the knowledge of thermodynamic potentials and to understand phase transition in thermodynamics, to identify the relationship between statistic and thermodynamic quantities, to comprehend the concept of partition function, canonical and grand canonical ensembles, to grasp the fundamental knowledge about the three types of statistics and to get in depth knowledge about phase transitions and fluctuation of thermodynamic properties that vary with time.

Course Outcomes:

At the end of the course the student will be able to

CO1:examine and elaborate the effect of changes in thermodynamic quantities on the states of matter during phase transition.

CO2:analyze the macroscopic properties such as pressure, volume, temperature, etc. using microscopic properties like intermolecular forces, chemical bonding, etc.

CO3:differentiate between canonical and grand canonical ensembles and to interpret the relation between thermodynamical quantities and partition function.

CO4:apply the different statistical concepts to analyze the behaviour of ideal Fermi gas and ideal Bose gas and also to compare the three types of statistics.

CO5:discuss and examine the applications of statistical mechanics and thermodynamical behaviour of gases under fluctuation by using Ising model.

Unit I: PHASE TRANSITIONS (12 Hours)

Thermodynamic potentials - Phase Equilibrium - Gibb's phase rule - Phase transitions and Ehrenfest's classifications –Third law of Thermodynamics- Order parameters – Landau's theory of phase transition - Critical indices - Scale transformations and dimensional analysis.

Unit II: STATISTICAL MECHANICS AND THERMODYNAMICS(12Hours)

Foundations of statistical mechanics - Specification of states of a system - Micro canonical ensemble - Phase space – Entropy - Connection between statistics and thermodynamics – Entropy of an ideal gas using the micro canonical ensemble - Entropy of mixing and Gibb's paradox.

Unit III: CANONICAL AND GRAND CANONICAL ENSEMBLES(12 Hours)

Trajectories and density of states - Liouville's theorem - Canonical and grand canonical ensembles - Partition function - Calculation of statistical quantities - Energy and density fluctuations.

Unit IV: CLASSICAL AND QUANTUM STATISTICS (12 Hours)

Density matrix - Statistics of ensembles - Statistics of indistinguishable particles - Maxwell-Boltzmann statistics - Fermi-Dirac statistics – Ideal Fermi gas – Degeneracy - Bose-Einstein statistics - Plank radiation formula - Ideal Bose gas - Bose-Einstein condensation.

Unit V:REAL GAS, ISING MODEL AND FLUCTUATIONS (12 Hours)

Simple harmonic oscillator problem - The principle of equi- partition of energy - Saha ionization formula - Specific heat of a degenerate electron gas - Virial equation of state - Ising model - Mean-field theories of the Ising model in one dimension - Brownian motion - Langevin's theory - Fluctuation-dissipation theorem - The Fokker-Planck equation.

Learning Resources:

Text books

1. S. K. Sinha,*Statistical Mechanics*, Tata McGraw Hill, New Delhi, 1990.
2. B. K. Agarwal and M. Eisner, *Statistical Mechanics*, 2nd Edition New Age International, New Delhi, 1998.
3. J. K. Bhattacharjee, *Statistical Mechanics: An Introductory Text*, Allied Publication, New Delhi, 1996.
4. F. W. Sears and G. L. Salinger, *Thermodynamics, Kinetic theory, and Statistical Thermodynamics*, Narosa Publishing House, 3rdEdition,1998.
5. F. Reif, *Fundamentals of Statistical and Thermal Physics*, McGraw -Hill, New York, 1965.
6. S.Lokanathan and R.S.Gambhir, *Statistical and Thermal Physics: An Introduction*, Prentice-Hall of India, New Delhi, 2000.

References

1. R. K. Pathria, *Statistical Mechanics*, 2nd Edition, Butter WorthHeinemann, New Delhi, 1996.
2. M. K. Zemansky, *Heat and Thermodynamics*, McGraw-Hill New York, 5thEdition,1968.
3. L. D. Landau and E. M. Lifshitz, *Statistical Physics*, Pergamon Press, Oxford, 1969.

4. K. Huang, *Statistical Mechanics*, Taylor and Francis, London, 2002.
5. W. Greiner, L. NeiseandH.Stoecker, *Thermodynamics and Statistical Mechanics*, Springer Verlang, New York, 1995.
6. A. B. Gupta, H. Roy, *Thermal Physics*, Books and Allied, Kolkata, 2002.

Websites/ e-Learning Resources

1. https://web.stanford.edu/~peastman/statmech/thermodynamics.html
3. https://en.wikiversity.org/wiki/Statistical_mechanics_and_thermodynamics
4. https://en.wikipedia.org/wiki/Grand_canonical_ensemble
5. https://en.wikipedia.org/wiki/Ising_model

CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO 1	3	2	3	2	3	2	3	3	2	2
CO 2	3	2	2	3	2	2	3	3	2	3
CO 3	3	3	2	3	2	3	2	3	3	3
CO 4	3	3	3	3	2	3	3	3	3	3
CO 5	3	2	3	3	3	3	3	3	1	2
Average	3	2.4	2.6	2.8	2.4	2.6	2.8	3	2.2	2.6

Strong – 3 Medium – 2 Low – 1

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PGP/PSP4408	**Practical - II**	**Core**	**9**	**4**

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.

Course Outcomes:

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

CO1: practice systematic laboratory work habits.
CO2: design experiments and verify theoretical concepts.
CO3: perform data and error analysis.
CO4: handle advanced equipment in the lab.
CO5: troubleshoot physics experiments.

List of Experiments
(Any 16 Experiments inclusive of electronics, non electronics, computer programming and microcontroller)

1. Determination of Young's modulus and Poisson's ratio by Elliptical fringes - Cornu's Method.

2. Determination of Stefan's constant of radiation from a hot body.
3. Measurement of Magnetic Susceptibility using Guoy's method.
4. LG Plate (Lummer-Gehrcke Plate) to absorb Zeeman effect and determination od e/m of the electron.
5. Determination of e/m using Millikan's method.
6. Miscibility measurements using ultrasonic diffraction method.
7. Determination of Thickness of thin film using Michelson Interferometer.
8. Verification of iterative equations for binary liquids using Ultrasonic interferometer.
9. Analyzing the Arc spectrum of metals (Iron, Copper, Brass)
10. Analyzing Iodine absorption spectra.
11. Measurement of dielectric constant using Microwave test bench.
12. Interpretation of vibrational spectra of a given material.
13. Determination of structural parameters using XRD.
14. Determination of Hysteresis loss by tracing B-H loop on the CRO.
15. Free fall – displacement-time graph, g calculation using charging and discharging.
16. Studying characteristics and dielectric constant in liquid and solids using Microwave.
17. Determination of nodal points of thick lens systems by using optical bench.
18. Graphics and mathematical analysis using MATH-CAD.
19. Studying the frequency response of FET CS amplifier and calculating the input and output impedance.
20. Solving simultaneous equations using IC 741 / IC LM324.
21. Construction of Current to Voltage and Voltage to Current Conversion using IC 741.
22. Construction of second order Butterworth multiple feedback narrow band pass filter
23. Realization of analog to digital converter (ADC) using 4-bit DAC and synchronous counter IC74193.
24. Construction of pulse generator using the IC 555 and its applicationas frequency divider.
25. BCD to Excess- 3 and Excess 3 to BCD code conversion.
26. Design of Shift register, Ring counter and Johnson counter using IC 7476/IC 7474.
27. Study of synchronous parallel 4-bit binary up/down counter using IC 74193.
28. Study of asynchronous parallel 4-bit binary up/down counter using IC 7493
29. Design of counters using flip flops, MOD counters using 7490.
30. Construction of FM modulation and demodulation.
31. Experiments in physics with expEYE-17.
32. Study of Pulse Width Modulation for DC motor control.
33. Stepper motor control using Ardiunomicro controller.
34. Construction of Op-Amp- 4 bit Digital to Analog converter (Binary Weighted and R/2R ladder type).
35. Study of RAM using ICs.
36. Numerical solution of ordinary first-order differential equations by the Euler method with Algorithm, Flow chart and output.
37. Numerical solution of ordinary first-order differential equations by the Runge- Kutta method with Algorithm, Flow chart and output.
38. Finding Roots of a Polynomial by Bisection Method using C programming.
39. Finding Roots of a Polynomial by Newton Raphson Method using C programming
40. Solution of Simultaneous Linear Equation by Gauss elimination method using C programming.

41. Solution of Ordinary Differential Equation by Euler using C programming.
42. Interfacing of DC stepper motor – Clockwise, Anti-clockwise, Angular movement and Wiper action using 8085 Microprocessor.
43. Interfacing of Temperature Controller and Measurement using 8085 Microprocessor.
44. Designing water level detector using 8051 Microcontroller.
45. Designing elevator using8051 Microcontroller.
46. Key board Interface using 8051 Microcontroller.
47. Addition, Subtraction, Multiplication and Division of 8-bit numbers using8085 Microprocessor.
48. Sum of a series of 8-bit numbers using8085 Microprocessor.
49. Average of N numbers using 8085 Microprocessor.

Learning Resources:

Text Books

1. Gupta and Kumar, *Practical Physics*, PragatiPrakasan Publisher, 2018.
2. R.Srinivasan K.R Priolkar, *Kit Developed for doing experiments in Physics- Instruction manual*, Indian Academy of Sciences, 2018.
3. S.Poornachandra, B.Sasikala, *Electronic Laboratory Primer a design approach*, Wheeler Publishing, New Delhi, 2005.
4. K. A. Navas, *Electronic lab manual Vol I*, Rajath Publishing, 2015.
5. K. A. Navas, *Electronic lab manual Vol II*, PHI eastern Economy Edition, 2018.

References

1. S.P Singh,*Advanced Practical Physics*, PragatiPrakasan Publisher, 2019.
2. D.Chattopadhayay, C.R Rakshit, *An Advanced Course in Practical Physics*, New Central Book Agency Pvt. Ltd, 1990.
3. Ramakanth A Gaykwad, *Op-Amp and linear integrated circuit*, Eastern Economy Edition, 2000.
4. R.S. Sirohi, *A course on experiment with He-Ne Laser*, John Wiley & Sons (Asia) Pvt. Ltd., 1989.
5. Kuriachan T.D, Syam Mohan, *Electronic lab manual Vol II*, Ayodhya Publishing., 2018.

CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO 1	2	2	2	3	2	2	2	1	2	3
CO 2	2	2	3	3	3	3	3	3	3	3
CO 3	3	3	3	3	3	3	3	3	3	3
CO 4	3	2	3	3	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	2	2	2	2
Average	2.6	2.4	2.8	3	2.8	2.8	2.6	2.4	2.6	2.8

Strong – 3 Medium – 2 Low – 1

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PGP/PSP4322	**Physics of Nanoscience and Technology**	**DSE**	**4**	**3**

This course is concerned with the study, creation, manipulation and applications at nanometer scale, provides the basic knowledge about nanoscience and technology and to learn the structures and properties of nanomaterials to acquire the knowledge about synthesis methods and characterization techniques and its applications.

Course Outcomes:

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

CO1:explainthe basic of nanoscience and explore the different types of nanomaterials and should comprehend the surface effects of the nanomaterials.

CO2: explore various physical, mechanical, optical, electrical and magnetic properties nanomaterials.

CO3:discussthe process and mechanism of synthesis and fabrication of nanomaterials.

CO4: analyze the various characterizations of nano-products through diffraction, spectroscopic, microscopic and other techniques.

CO5: apply the concepts of nanoscience and technology in the field of sensors, robotics, purification of air and water and in the energy devices.

Unit I: FUNDAMENTALS OF NANOSCIENCE AND TECHNOLOGY

(12 Hours)

Fundamentals – Historical perspective on nanomaterial and nanotechnology – Classification of nanomaterials – Metal and semiconductor nanomaterials - 2D, 1D, 0D nanostructured materials - Quantum dots – Quantum wires – Quantum wells - Surface effects of nanomaterials.

Unit II: PROPERTIES OF NANOMATERIALS (12 Hours)

Physical properties of Nanomaterials: Melting points, specific heat capacity, and lattice constant - Mechanical behavior: Elastic properties –Strength -Ductility - Superplastic behavior - Optical properties: - Surface plasmonresonance – Quantum size effects - Electrical properties - Conductivity, Ferroelectrics and dielectrics - Magnetic properties –Super para magnetism – Diluted magnetic semiconductor (DMS).

Unit III: SYNTHESIS AND FABRICATION (12 Hours)

Physical vapour deposition - Chemical vapour deposition - Sol-gel – Wet deposition techniques - Electrochemical deposition method – Plasma arching - Electrospinning method - Ball milling technique - Pulsed laser deposition - Nanolithography: Photolithography –Nanomanipulator.

Unit IV: CHARACTERIZATION TECHNIQUES (12 Hours)

Powder X-Ray diffraction – X-Ray photoelectron spectroscopy (XPS) - UV-visible spectroscopy – Photoluminescence - Scanning electron microscopy (SEM) - Transmission electron microscopy (TEM) - Scanning probe microscopy (SPM) - Scanning tunneling microscopy (STM) – Vibrating sample Magnetometer.

Unit V: APPLICATIONS OF NANOMATERIALS (12 Hours)

Sensors: Nanosensors based on optical and physical properties - Electrochemical sensors – Nano-biosensors. Nano electronics: Nanobots - display screens - GMR read/write heads - Carbon nanotube Emitters – Photocatalytic application: Air purification, water purification -Medicine: Imaging of cancer cells – Biological tags - Drug delivery - Photodynamic therapy - Energy: fuel cells - Rechargeable batteries - Supercapacitors - Photovoltaics.

Learning Resources:

Text Books

1. Pradeep T., *A textbook of Nanoscience and Nanotechnology*, Tata McGraw-Hill Publishing Co., 2012.
2. M.A. Shah, Tokeer Ahmad, *Principles of Nanoscience and Nanotechnology*, Narosa Publishing House Pvt Ltd., 2010.
3. C.P. Poole Jr, F.J. Owens, *Introduction to Nanotechnology*, Wiley Students Edition, 2007.
4. K. K. Chattopadhyay and A.N. Banerjee,*Introduction to Nanoscience and Nanotechnology*, PHI Learning Pvt. Ltd., New Delhi, 2012.
5. Hari Singh Nalwa, *Nanostructured Materials and Nanotechnology*, Academic Press, 2002.
6. D.P. Kothari, V. Velmurugan and Rajit Ram Singh, *Nanotechnology and Nanoelectronics*, Narosa Publishing House Pvt. Ltd, New Delhi, 2018.

References

1. HuozhongGao, *Nanostructures and Nanomaterials*, Imperial College Press, 2004.
2. Richard Booker and Earl Boysen, *Nanotechnology*, Wiley Publishing Inc. USA, 2005.
3. J. H. Fendler, *Nano particles and Nano structured films; Preparation, Characterization and Applications*, John Wiley and Sons., 2007.
4. B. S. Murty, et al., *Textbook of Nanoscience and Nanotechnology*, Universities Press., 2012.
5. Dr. Parag Diwan and Ashish Bharadwaj, *TheNanoscope (Encyclopedia of Nanoscience and Nanotechnology)* Vol. IV - Nanoelectronics Pentagon Press, New Delhi, 2005.

Websites/ e-Learning Resources

1. http://www.understandingnano.com
2. http://www.nano.gov

CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO 1	3	3	3	2	1	1	3	3	3	2
CO 2	3	3	3	2	1	1	3	3	3	3
CO 3	3	3	2	2	1	1	3	3	3	3
CO 4	3	3	3	2	1	1	3	3	2	1
CO 5	3	3	2	2	1	1	3	1	1	2
Average	3	3	2.6	2	1	1	3	2.6	2.4	2.2

Strong – 3 Medium – 2 Low – 1

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PGP/PSP4324	Crystal Growth and Thin Films	DSE	4	3

This course helps to acquire the knowledge on Nucleation and Kinetics of crystal growth and to understand the crystallization principles and growth techniques, to study various methods of Crystal growth techniques, also to understand the thin film deposition methods and to apply the techniques of Thin Film Formation and thickness Measurement.

Course Outcomes:

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

CO1: acquire the basic concepts, nucleation and kinetics of crystal growth.
CO2:explain the crystallization principles and growth techniques.
CO3: study various methods of crystal growth techniques.
CO4:discussthethin film deposition methods.
CO5: apply the techniques of thin Film formation and thickness measurement.

Unit I: CRYSTAL GROWTH KINETICS (12 Hours)

Basic concepts, Nucleation and kinetics of growth ambient phase equilibrium - Super saturation - Equilibrium of finite phases equation of Thomson - Gibbs - Types of nucleation - Formation of critical nucleus - Classical theory of nucleation - Homo and heterogeneous formation of 3D nuclei - Rate of nucleation - Growth from vapour phase solutions, solutions and melts - Epitaxial growth - Growth mechanism and classification - Kinetics of growth of epitaxial films.

Unit II: CRYSTALLIZATION PRINCIPLES (12 Hours)

Crystallization principles and growth techniques classes of crystal system - Crystal symmetry - Solvents and solutions - Solubility diagram - Super solubility - expression for super saturation - metastable zone and introduction period - Miers TC diagram - Solution growth - Low and high temperatures solution growth - Slow cooling and solvent evaporation methods - Constant temperature bath as a Crystallizer.

Unit III: GEL, MELT AND VAPOUR GROWTH (12 Hours)

Gel, Melt and Vapour growth techniques principle of Gel techniques - Various types of gel - Structure and importance of gel - Methods of gel growth and advantages - Melt techniques - Czochralski growth - Floating zone - Bridgeman method - Horizontal gradient freeze - Flux growth - Hydrothermal growth - Vapour phase growth - Physical vapour deposition - Chemical vapour deposition - Stoichiometry.

Unit IV: THIN FILM DEPOSITION METHODS (12 Hours)

Thin film deposition methods of thin film preparation - Thermal evaporation - Electron beam evaporation - pulsed LASER deposition - Cathodic sputtering - RF Magnetron sputtering – MBE -Chemical vapour deposition methods - Sol-gel spin coating - Spray pyrolysis - Chemical bath deposition.

Unit V: THIN FILM FORMATION (12 Hours)

Thin film formation and thickness measurement nucleation, film growth and structure - Various stages in thin film formation - Thermodynamics of nucleation - Nucleation theories - Capillarity model and atomistic model and their comparison - Structure of thin film - Role of substrate - Role of film thickness - Film thickness measurement – Interferometry –Ellipsometry - Micro balance - Quartz crystal oscillator techniques.

Learning Resources:

Text Books

1. V. Markov *Crystal growth for beginners: Fundamentals of Nucleation, Crystal Growth and Epitaxy*, 2nd Edition, 2004.
2. Goswami, *Thin Film Fundamentals*, New Age, New Delhi, 2008.
3. M. Ohora and R. C. Reid, *Modeling of Crystal Growth Rates from Solution*, Prentice-Hall, 2004.
4. D. Elwell and H. J. Scheel, *Crystal Growth from High Temperature Solution*, 1976.
5. Heinz K. Henish, *Crystal Growth in Gels*, Cambridge University Press. USA, 1973.

References

1. J.C. Brice, *Crystal Growth Process* , John Wiley, New York, 1986.
2. P. Ramasamy and F. D. Gnanam, *UGC Summer School Notes*, 1983.
3. P. SanthanaRaghavan and P. Ramasamy, *Crystal Growth Processes*, KRU Publications, 2001.
4. H.E. Buckley, *Crystal Growth*, John Wiley and Sons, New York, 1951.
5. B.R. Pamplin, *Crystal Growth*, Pergman Press, London, 1980.

Websites/ e-Learning Resources

1. https://www.youtube.com/playlist?list=PLbMVogVj5nJRjLrXp3kMtrIO8kZl1D1Jp
2. https://www.youtube.com/playlist?list=PLFW6lRTa1g83HGEihgwcy7KeTLUuBu3WF
3. https://www.youtube.com/playlist?list=PLADLRin7kNjG1Dlna9MDA53CMKFHPSi9m
4. https://www.youtube.com/playlist?list=PLXHedI-xbyr8xIl_KQFs_R_oky3Yd1Emw
5. https://www.electrical4u.com/thermal-conductivity-of-metals/

CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO 1	3	2	1	2	1	3	2	2	2	2
CO 2	3	3	1	3	1	2	3	2	2	2
CO 3	3	2	1	3	1	2	3	3	3	2
CO 4	3	2	1	2	1	2	3	3	3	2
CO 5	2	3	3	3	1	3	3	1	1	2
Average	2.8	2.4	1.4	2.6	1	2.4	2.8	2.2	2.2	2

Strong – 3 Medium – 2 Low – 1

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PGP/PSP4312	**Physics in Human Physiology**	**GE**	**4**	**3**

This course enables learners to relate some of the concepts in Physics to living systems by organizing discussions in to specific areas of the human body.

Course outcomes:

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

CO1: acquire knowledge about the forces that act on the human body.
CO2: discriminate the response of the human body under translational and rotational motions.
CO3: explain the flow of blood in the circulatory system of the human body.
CO4: analyse the energy consumption and temperature control of the human body and some biological aspects of sound.
CO5: describe the Physics of vision and various defects in vision.

Unit I:FRICTION AND STATIC FORCES ON THE HUMAN BODY

(12 Hours)

Centre of gravity- Equilibrium and stability - Equilibrium considerations for the human body - Stability against a toppling force - Skeletal muscles – Classes of lever – Lever representation of the elbow – Lever representations of the hip and the back - Dynamic aspects of posture. Frictional force - Standing at an incline - Friction at the hip joint.

Unit II: TRANSLATIONAL AND ROTATIONAL MOTIONS OF THE HUMAN BODY

(12 Hours)

Forces on a vertical jumper – Height of the vertical jump – Running high jump - Range of a projectile – Forces on a standing broad jumper - Running broad jump- Forces on a curved Path – Coefficient of friction - A runner on a curved track – The simple pendulum - Maximum velocity of the swinging foot - Physical pendulum - Speed of walkingandrunning - Alternate perspectives on walking and running.

Unit III: FLUIDS MOTION IN THE HUMAN BODY (12 Hours)

Force and pressure in a Fluid - Pascal's Principle - Hydrostatic skeleton - Archimedes' principle - Power required to remain afloat - 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 - Power produced by the heart - Measurement of blood pressure.

Unit IV:ENERGY AND HEARING MECHANISM OF THE HUMAN BODY (12 Hours)

Energy requirements of people - Energy from food - Regulation of body temperature - Control of skin temperature - Convection - Radiation - Evaporation - Resistance to cold - Heat and soil – Green houseeffect.

Hearing and the ear: Sounds produced by animals - Bats and echoes - Acoustic traps - Clinical uses of sound: Ultrasonic waves – Doppler effect.

Unit V: PHYSICS OF THE HUMAN EYE AND VISION (12 Hours)

Vision - Nature of light - Structure of the human eye - Accommodation - Eye and the camera – Aperture and depth of field - Lens system of the eye – Determination of the image size - 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.

Learning Resources:

Text Book

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

References

1. VasanthaPattabhi and N. Gautham, *Biophysics*, Kluwer academic publishers, 2002.
2. Irving P. Herman, *Physics of the Human Body*, Springer, Second Edition, 2016.

Websites/ e-Learning Resources

1. https://www.selfstudys.com/books/neet-biology/english/notes/5-human-physlology/11010
2.https://www.cartercenter.org/resources/pdfs/health/ephti/library/lecture_notes/nursing_students/ln_human_anat_final.pdf

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	3	2	3	3	2	2	2	3	2	3
CO 2	3	2	3	2	2	2	2	2	2	1
CO 3	3	2	2	2	3	2	2	3	3	3

CO 4	3	3	2	3	3	2	3	2	3	3
CO 5	3	3	2	2	3	2	3	2	2	2
Average	3	2.4	2.4	2.4	2.6	2	2.4	2.4	2.4	2.4

Strong – 3 Medium – 2 Low – 1

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PGP/PSP4314	**Sustainable Energy Resources**	**GE**	**4**	**3**

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

Course Outcomes

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

CO 1: list the characteristics of renewable energy.
CO 2: express the significance of solar radiation and their applications.
CO 3: illustrate the energy extraction from wind, tides and organic substances.
CO 4: categorize the thermal energy conversions in ocean and earth's core.
CO 5: interpret different forms of energy storage and their transmission.

Unit I: PRINCIPLES OF RENEWABLE ENERGY (12 Hours)

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 (12 Hours)

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-voltaic systems and their applications.

Unit III: ENERGY CONVERSION SYSTEMS (12 Hours)

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 (12 Hours)

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 (12 Hours)

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.

Learning Resources:

Text Books

1. John Twidell and Tony Weir, *Renewable Energy Resources*, London, Taylor& Francis Group, 2nd Edition, 2006.
2. G.D. Rai, *Non – convention sources*, 4th Edition, Khanna publishers, New Delhi, 1996.
3. G.D.Rai, *Solar Energy Utilization*, Khanna Publication, New Delhi, 1995.

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.

Websites/ e-Learning Resources

1. https://www.routledge.com/blog/article/what-is-sustainable-energy-and-why-do-we-need-it
2. https://www.repsol.com/en/energy-and-the-future/future-of-the-world/sustainable-energy/index.cshtml

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	3	2	3	3	3	2	2	2	3	3
CO 2	3	2	3	3	3	2	2	2	2	3
CO 3	3	2	3	3	2	2	3	3	3	1
CO 4	2	2	2	3	3	2	2	2	3	3

CO 5	3	2	2	3	3	2	2	3	1	1
Average	3	2	2.6	3	2.8	2	2.4	2.4	2.4	2.2

Strong – 3 Medium – 2 Low – 1