

M.Sc. PHYSICS

LOCF SYLLABUS 2026



Department of Physics

School of Physical Sciences

St. Xavier's College (Autonomous), Palayamkottai

Tirunelveli – 627 002, Tamil Nadu, India

w.e.f. 2026–27

Vision

To mould young men and women as leaders in all walks of life so that they may serve the people especially the poor and the oppressed of our nation in truth, justice and love.

Mission

To achieve a synthesis of academic excellence and the formation of character.

To ensure social justice through equity and access

To include the excluded for empowerment

To equip students with global competencies

To engage in relevant research activities.

To promote Lab to Land through the Outreach Programme – Student Training and Action for Neighbourhood Development (STAND)

SCHOOLS OF EXCELLENCE WITH CHOICE-BASED CREDIT SYSTEM (CBCS)

Essential Features of CBCS

Standardisation of degree courses to internationally accepted levels

Focus on skill-based curriculum

Emphasis on value education

Institution - Industry collaboration

Provision for earning more credits

Development of communication skills

Post Graduate Courses

The existing PG curriculum was thoroughly upgraded based on the expectations of the academicians and the aspirations of the student community. The PG syllabus has two parts : Core and Elective. The minimum number of credits to be earned by a student is 100. The aim of the project work at the PG level is to develop the skill of solving problems and to promote research motivation. All the I-year PG students are offered one Value - Added Course and during their II year they are supposed to do one Extra Credit course outside their class hours to enhance their employability skills. However, during every semester, they are free to learn one ECC paper, offered by the respective departments.

Credit system

The credit system at St. Xavier's College (Autonomous) assigns weightage to courses based on the hours allocated to each course. Typically, one credit is equivalent to one hour of instruction per week. However, credits are awarded regardless of actual teaching hours to ensure consistency and adherence to guidelines. The credits and hours allotted to each course within a programme are detailed in the Programme Pattern table. While the table provides a framework, there may be some flexibility due to practical sessions, field visits, tutorials, and the nature of project work. For postgraduate (PG) courses, students are required to accumulate a minimum of 100 credits, as stipulated in the programme pattern table. The total number of courses offered by the department is outlined in the Programme Structure.

OUTCOME-BASED EDUCATION (OBE)

Outcome-Based Education (OBE) is a student-centric teaching and learning methodology that focuses on measuring student performance through clearly defined outcomes. For St. Xavier's College, with its commitment to excellence and NAAC/NBA accreditation requirements, OBE is not just a regulatory expectation but a pathway to academic quality, global competitiveness, and improved employability of graduates.

We prepare students to meet future industry requirements and reinforce St. Xavier's College, Palayamkottai, as a leader in quality higher education. St. Xavier's College introduced OBE in 2018, and for the Attainment Calculation, we developed our own method in 2018. From the academic year 2025-26 onwards, in examinations, for each question we mark Course Outcome (CO), Competency and Performance Indicator, Programme Outcome / Programme Specific Outcome, Bloom's Revised Cognitive Level and we follow the OBE procedure for the calculation of the Attainment of Outcome for each student, course, semester, programme.

EVALUATION PATTERN (PG)

Continuous Internal Assessment

There is no internal minimum for any paper. However, Continuous Internal Assessment (CIA) is a mandatory requirement for all students. A student must take at least one CIA test out of two tests and must fulfil at least one mode of assessment among assignments, quiz, seminars, etc., otherwise he/she will not be permitted to write the semester examination.

S.No	Component	Marks Allotted
1	I CIA Test	70
2	II CIA Test	70
	Total	140

The total CIA marks of 140 will be converted to 70 marks. An additional 30 marks will be awarded through other internal assessment components.

The Continuous Internal Assessment (CIA) consists of two component tests, each carrying 15 marks (15 + 15).

The final internal assessment marks will be calculated out of 100 (70 + 30). The obtained marks will be converted to 50 marks.

Semester (External) Examination

- The External Semester Examination will be conducted for 100 marks.
- The obtained marks will be converted to 50 marks.

Question Pattern

PG Semester Examinations (3 Hours)

PART	TYPE	Mark Distribution	Total Marks
A	MCQ	10X1	10
B	ALL	5X3	15
C	Either/or	5X6	30
D	3 out of 5	3X15	45
		Total	100

PG Internal Examinations (2 Hours)

PART	TYPE	Mark Distribution	Total Marks
A	MCQ	10X1	10
B	ALL	3X3	09
C	Either/or	3x7	21
D	3 out of 5	3X10	30
		Total	70

Grading System

Range of Marks	Letter Grade	Grade Point	Description
90-100	A+	9.0-10.0	Outstanding
80-89	A	8.0-8.9	Excellent
70-79	B+	7.0-7.9	Very Good
60-69	B	6.0-6.9	Good
50-59	U	5.0-5.9	Average
00-49	U	0	Reappear

Programme Outcome

Upon graduation, students across all Postgraduate Degree Programmes shall demonstrate the following competencies:

- **PO1. Critical Thinking:** To acquire specialized knowledge in their respective disciplines and implement informed decisions.
- **PO2. Communication:** To articulate, read, write, and comprehend effectively through direct interaction and electronic media in English and one Indian language, deriving world meanings by synthesizing diverse resources.
- **PO3. Individual and Teamwork:** To function proficiently as an individual contributor and as a collaborative participant or leader within heterogeneous teams and multidisciplinary environments.
- **PO4. Problem Analysis:** To identify, formulate, and review research literature to analyze complex challenges, reaching validated conclusions utilizing foundational principles across Sciences,

Commerce, and Humanities.

- **PO5. Design/Development of Solutions:** To construct solutions for problems and design systems or processes that satisfy specific requirements while accounting for public health, safety, and socio-environmental factors.
- **PO6. Conduct Investigations of Complex Problems:** To utilize research-based insights and experimental methodologies, including data synthesis and interpretation, to establish valid scientific conclusions.
- **PO7. Modern Tool Usage:** To select and apply appropriate techniques and contemporary IT resources, including predictive modeling, for complex tasks while acknowledging inherent limitations.
- **PO8. Self-directed and Life-long Learning:** To recognize the necessity for and possess the capacity to engage in autonomous, continuous learning within the context of rapid technological and social evolution.

Programme Specific Outcomes

At the completion of the M.Sc., programme in Physics the students must be empowered to

1. Face the challenges of constantly evolving science world honing their ability
2. Apply and formulate the solutions of emerging scientific problems
3. Pursue Higher studies in physics
4. Handle any scientific equipments by providing hands on experience with practical instruments
5. Face competitive exams like NET/SET as the course papers designed based on the NET syllabus
6. Have the finer dimensions of physics by providing foundations for transparencies of scientific knowledge at specialization level
7. To be inspired and oriented for research activities
8. Develop their employability skills by equipping students with multi practical dimensions

M.Sc. PHYSICS PROGRAMME PATTERN

(With Effect from June 2026)

Sem	Part	Status	Sub. Code	Title of the Paper	Hrs	Cd t
I	A	Core-1	26PPHC11	Mathematical Physics	6	4
		Core-2	26PPHC12	Classical Mechanics and Relativity	6	4
		Core-3	26PPHC13	Linear and Digital ICs and Applications	6	4
		Core-4	26PPHC14	Practical-I Electronics-I	4	2
	B	EC-1	26PPHE11	Communication Electronics / Astro Physics	4	4
		EC-2	26PPHE12	Practical-II General Physics Experiments - I	4	2
					30	20
II	A	Core-5	26PPHC21	Statistical Mechanics	6	5
		Core-6	26PPHC22	Quantum Mechanics-I	6	5
		Core-7	26PPHC23	Condensed Matter Physics	6	5
	B	EC-3	26PPHE21	Medical Physics / Solar Energy Utilization	4	3
		EC-4	26PPHE22	Practical-III Electronics-II	4	2
		SEC-1	26PPHS21	Practical-IV General Physics Experiments - II	4	2
	C	Extension Activities		STAND (Student Training and Action for Neighbourhood Development)		1
					30	23
III	A	Core-8	26PPHC31	Quantum Mechanics-II	6	5
		Core-9	26PPHC32	Electromagnetic Theory	6	5
		Core- 10	26PPHC33	Nuclear and Particle Physics	6	5
		Core- 11	26PPHC34	Practical-V Microprocessor 8086	4	2
	B	EC-5	26PPHE31	Microprocessor 8086 and Microcontroller / Introduction to Python Programming	4	5
		SEC-2	26PPHS31	Practical-VI Microcontroller 8051	4	2
		Internship	26PPHI35	Carried out in summer vacation at the end of Sem II	-	2
					30	26
IV	A	Core- 12	26PPHC41	Spectroscopic Techniques	6	5
		Core- 13	26PPHC42	Numerical Methods And Programming With C++	6	5
		Project	26PPHC43	Project with Viva-Voce	10	7
	B	EC-6	26PPHE41	Physics of Nano Science and Technology /Atmospheric Physics	4	3
		SEC-3	26PPHS41	Practical-VII Numerical Methods using C	4	2
					30	22
					120	91
				ADDITIONAL COMPULSORY COURSES		

I PG		Value Added	26PPHVA1 /26PPHVA2	Introduction to Artificial Intelligence / Quantum Computing		3
II PG		ECC	26PPHEC1/ 26PPHEC2/ 26PPHEC3/ 26PPHEC4	Energy Physics / Characterization of Materials / Introduction to Unmanned Aircraft Systems / Laser Physics		3
		MOOC		Program-related massive open online course (From Swayam NPTEL Online)		2
		Field Visit		Program-related field or industrial visit		1
					120	100

Abbreviations and Meanings:

PPH - PG Physics, C – Core, EC(E) - Elective Course, SEC(S) - Skill Enhancement Course, ECC(EC) - Extra Credit Course, CC - Certificate Course (Value Added Course), I – Internship, CO - Course Outcomes, K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

INDEX OF THE CURRICULUM

S.No	Sem	Sub Code	Subject	Hour	Cdt	Page
1.	I	26PPHC11	Mathematical Physics	6	4	1
2.	I	26PPHC12	Classical Mechanics and Relativity	6	4	3
3.	I	26PPHC13	Linear and Digital ICs and Applications	6	4	5
4.	I	26PPHC14	Practical-I Electronics-I	4	2	7
5.	I	26PPHE11	Communication Electronics	4	4	8
6.	I	26PPHE11	Astro Physics	4	4	10
7.	I	26PPHE12	Practical-II General Physics Experiments - I	4	2	12
8.	II	26PPHC21	Statistical Mechanics	6	5	13
9.	II	26PPHC22	Quantum Mechanics-I	6	5	15
10.	II	26PPHC23	Condensed Matter Physics	6	5	17
11.	II	26PPHE21	Medical Physics	4	3	19
12.	II	26PPHE21	Solar Energy Utilization	4	3	21
13.	II	26PPHE22	Practical-III Electronics-II	4	2	23
14.	II	26PPHS21	Practical-IV General Physics Experiments - II	4	2	24
15.	III	26PPHC31	Quantum Mechanics-II	6	6	25
16.	III	26PPHC32	Electromagnetic Theory	6	6	27
17.	III	26PPHC33	Nuclear and Particle Physics	6	6	29
18.	III	26PPHC34	Practical-V Microprocessor 8086	4	2	31
19.	III	26PPHE31	Microprocessor 8086 & Microcontroller	4	4	32
20.	III	26PPHE31	Introduction to Python Programming	4	4	33
21.	III	26PPHS31	Practical-VI Microcontroller 8051	4	2	35
22.	IV	26PPHC41	Spectroscopic Techniques	6	5	36
23.	IV	26PPHC42	Numerical Methods and Computer Programming	6	5	38
24.	IV	26PPHE41	Physics of Nano Science & Technology	4	3	40
25.	IV	26PPHE41	Atmospheric Physics	4	3	42
26.	IV	26PPHS41	Practical-VII Numerical Methods using C	4	2	44
27.	VAC	26PPHVA1	Introduction to Artificial Intelligence	-	3	45
28.		26PPHVA2	Quantum Computing	-	3	47
29.	ECC	26PPHEC1	Energy Physics	-	3	49
30.		26PPHEC2	Characterisation of Materials	-	3	51
31.		26PPHEC3	Introduction to Unmanned Aircraft Systems	-	3	53
32.		26PPHEC4	Laser Physics	-	3	55

MATHEMATICAL PHYSICS
(Course Code: 26PPHC11)

Semester I	Core 1	Hours 6	Credits 4
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Course Outcomes: At the end of the course the students must be able to

- CO1** Apply advanced mathematical methods to solve problems in classical and modern physics (K1)
- CO2** Analyze differential equations, vector calculus, and complex variables used in physical Systems (K2)
- CO3** Utilize linear algebra, matrices, and tensors in quantum mechanics and other physical applications (K3).
- CO4** Interpret Fourier series, Laplace transforms, and special functions for modeling physical phenomena. (K4)
- CO5** Develop analytical and computational skills for solving boundary value and eigenvalue problems. (K5)
- CO6** Solve ordinary and partial differential equations arising in various physical systems and boundary value problems (K6)

UNIT I: VECTOR SPACE, TENSORS, BETA & GAMMA FUNCTIONS (18 Hours)

Basic concepts of vector space – Linear independence – Inner product – Scalar product – Orthogonality – Gram–Schmidt orthogonalization procedure – Tensors – Basic ideas – Covariant – Contravariant – Mixed Tensors
Beta Function – Symmetry properties – Evaluation – Transformation – Gamma Function – Evaluation – Transformation – Relation between Beta and Gamma Function.

UNIT II: COMPLEX ANALYSIS (18 Hours)

Review of Complex Numbers – de Moivre's theorem – Analytic functions – Cauchy – Riemann conditions – Singular points – Cauchy's Integral Theorem and integral Formula – Taylor's Series – Laurent's Expansion – Cauchy Residue theorem – Definite integrals by Contour Integration

UNIT III: MATRICES & GROUP THEORY (18 Hours)

Types of Matrices and their properties, Rank of a Matrix – Conjugate – Adjoint – Inverse – Hermitian and Unitary Matrices – Trace & Transformation of matrices – Characteristic equation – Eigen values and Eigen vectors – Cayley–Hamilton theorem
Introduction to groups – elementary properties – abelian group – cyclic & point groups – symmetry operations – Multiplication table – Reducible representation – character table for C_{2v} and C_{3v} point groups

UNIT IV: FOURIER & LAPLACE TRANSFORMS (18 Hours)

Definitions – Fourier transform – Properties – Fourier Sine and Cosine Transform – Derivative of Fourier Transform – Fourier sine and cosine transform of derivatives – Applications.

Laplace transform – Properties – Laplace transform of derivatives and integrals – Laplace transform of periodic functions. – Inverse Laplace transform – Properties – Applications.

UNIT V: DIFFERENTIAL EQUATIONS

(18 Hours)

Power Series Solution: Legendre differential equation and functions – Generating function – Rodrigue formula – Orthogonality properties–Recurrence relations – Bessel's Differential equations– Generating functions –Orthogonalityproperties –Recurrence relations –Hermite polynomials – Generating function –Orthogonality properties – Recurrence relations.

BOOKSFORSTUDY:

1. Mathematical Physics, Sathyaprakash, Sulthanchand& sons, New Delhi 2005
2. Mathematical Physics , H.K. Das, S.Chand& Company, New Delhi 2014
3. Mathematical Physics, B.S.Rajput, 20th Edition, Pragati Prakashan, 2008.

BOOKSFORREFERENCE:

1. E.Kreyszig, 1983, Advanced Engineering Mathematics, WileyEastern, NewDelhi,
2. D.G.ZillandM.R.Cullen, 2006, Advanced Engineering Mathematics, 3rdEd. Narosa, New Delhi.
3. S.Lipschutz, 1987, Linear Algebra, Schaum's Series, McGraw–Hill, New York 3.
4. George Arfken and Hans J Weber, 2012, Mathematical Methods for Physicists–A Comprehensive Guide (7th edition), Academic press.
5. P.K.Chattopadhyay, 2013, Mathematical Physics (2ndedition), NewAge, NewDelhi
6. AWJoshi, 2017, Matrices and Tensors in Physics, 4th Edition (Paperback), NewAge International Pvt.Ltd., India

WEB SOURCES

- www.khanacademy.org
- https://youtu.be/LZnRIOA1_2I
- <http://hyperphysics.phy-astr.gsu.edu/hbase/hmat.html#hmath>
- https://www.youtube.com/watch?v=_2jymuM7OUU&list=PLhkiT_RYTEU27vS_SIED56gNjVJGO2qaZ

CLASSICAL MECHANICS AND RELATIVITY

(Course Code: 26PPHC12)

Semester I	Core 2	Hours 6	Credits 4
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Course Outcomes: At the end of the course the students must be able to

1. Remember the concepts of Lagrangian and Hamiltonian formulation. (K1)
2. Illustrate the two body central force problems and its solutions and also about the solving ability of scattering theory. (K2)
3. Understand the importance of variational principles and get familiar with Poisson and Lagrange brackets. (K3)
4. Analyse the dynamics of rigid body problems in detail and solve its various problems. (K4)
5. Access the theory of oscillations in detail with the basis of free vibrations. (K5)
6. Creating basic ideas of theory of relativity and the concepts in relativistic mechanics.(K6)

UNIT I : PRINCIPLES OF CLASSICAL MECHANICS

(18 HOURS)

Introduction–newtons law of motion –Mechanics of a single particle: conservation laws (linear momentum, angular momentum, work – energy theorem and conservation theorem) – mechanics of a system of particles – centre of mass – constraints – holonomic& non-holonomic constraints – generalized coordinates– Degrees of freedom – principle of virtual work and virtual displacement.

UNIT II : LAGRANGIAN FORMULATION

(18 HOURS)

D'Alembert's principle –Lagrange's equations of motion for conservative systems from D'Alembert's principle–Applications: (i) Newton's equation of motion from Lagrange's equations (ii) simple pendulum (iii) Atwood's machine.

UNIT III: HAMILTONIAN FORMULATION

(18 HOURS)

Generalized momentum and cyclic coordinate – Hamiltonian (H) function and conservation of energy: Jacobi's integral– Hamilton's canonical equations of motion – Applications: Harmonic oscillator (ii) motion of particle in a central force field (iii) compound pendulum

UNIT IV: DYNAMICS OF A RIGID BODY AND SMALL OSCILLATIONS (18 Hours)

Euler's Angles- Moments and Products of Inertia- Euler's equation of motion of a rigid body - force free motion of a symmetry top - General theory of small oscillations- Eigen value equation – normal frequencies of free vibration and normal coordinates – Vibrations of a linear tri atomic molecule.

UNIT V: THEORY OF RELATIVITY & RELATIVISTIC MECHANICS

(18 Hours)

Inertial and non-inertial frames - Lorentz transformation- Consequences of Lorentz transformations – Length contraction- Time dilation – Addition of velocities – Relativistic energy – Einstein's mass energy relation - particle with zero mass - force in relativistic mechanics - Lagrangian and Hamiltonian formulation of relativistic mechanics

BOOKS FOR STUDY:

1.J.C.Upadhyaya, Classical Mechanics, Himalaya publishing house, 2011.

2. Herbert Goldstein, Classical Mechanics, Narosa Publication House, 3rd Edition, 2012.
3. R. Resnick, 1968, Introduction to Special Theory of Relativity, Wiley Eastern, New Delhi.
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.

BOOKS FOR REFERENCES:

1. Rana. N.C. and Joag, Classical Mechanics, Tata McGraw Hill, New Delhi, 1998.
2. A.K. Saxena, Classical Mechanics, Tata McGraw Hill, New Delhi, 1998
3. S.L Gupta, V.Kumar, H.V.Sharma, Classical Mechanics, Pragathi prakasan, 6th Edition, 2000.
4. V.B. Batia, Classical Mechanics, Narosa Pub. Ltd, New Delhi, 1997.
5. K. R. Symon, 1971, Mechanics, Addison Wesley, London.

WEB SOURCES

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-edition-pdf-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>

LINEAR AND DIGITAL ICs & APPLICATIONS

(Course Code: 26PPHC13)

Semester I	Core 3	Hours 6	Credits 4
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Course Outcomes: At the end of the course the students must be able to

- CO1 Explain the classification, features, and characteristics of operational amplifiers. (K2)
CO2 Apply Op–Amp circuits for mathematical problem solving, converters, and waveform generation. (K3)
CO3 Analyze active filters, timer circuits, and PLLs for communication and signal conditioning. (K4)
CO4 Evaluate voltage regulators and DAC/ADC architectures based on specifications and performance. (K5)
CO5 Design combinational logic circuits using CMOS and TTL ICs. (K6)
CO6 Develop sequential circuits such as flip-flops, counters, and shift registers for digital systems. (K6)

UNIT I: INTEGRATED CIRCUITS AND OPERATIONAL AMPLIFIER (18 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 (18 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 (18 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, PLL – introduction

UNIT IV: VOLTAGE REGULATOR & D to A AND A to D CONVERTERS (18 Hours)

VOLTAGE REGULATOR: Introduction, Series Op–Amp regulator, IC Voltage Regulators, 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 (18 Hours)

CMOS LOGIC: CMOS logic levels, MOS transistors, Basic CMOS Inverter, NAND and NOR gates. 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).

BOOKS FOR STUDY:

1. D. Roy Choudhury, Shail B. Jain (2012), Linear Integrated Circuit, 4th edition, New Age International Pvt.Ltd.,NewDelhi,India
2. Ramakant A. Gayakwad, (2012), OP–AMP and Linear Integrated Circuits, 4th edition, Prentice Hall / Pearson Education, NewDelhi.
3. B.L. Theraja and A.K. Theraja, 2004, A Textbook of Electrical technology, S. Chand & Co.
4. V.K. Mehta and Rohit Mehta, 2008, Principles of Electronics, S. Chand & Co, 12th Edition.
5. V. Vijayendran, 2008, Introduction to Integrated electronics (Digital & Analog),

BOOKS FOR REFERENCE:

1. Sergio Franco (1997), Design with operational amplifiers and analog integrated circuits, McGraw Hill, New Delhi.
2. Gray, Meyer (1995), Analysis and Design of Analog Integrated Circuits, Wiley International, New Delhi.
3. Malvino and Leach (2005), Digital Principles and Applications 5th Edition, Tata McGraw Hill, New Delhi
4. Floyd, Jain (2009), Digital Fundamentals, 8th edition, Pearson Education, New Delhi.
5. Integrated Electronics, Millman & Halkias, Tata McGraw Hill, 17th Reprint (2000)

WEB SOURCES

1. [https://nptel.ac.in/course.html/digital circuits/](https://nptel.ac.in/course.html/digital%20circuits/)
2. [https://nptel.ac.in/course.html/electronics/operational amplifier/](https://nptel.ac.in/course.html/electronics/operational%20amplifier/)
3. <https://www.allaboutcircuits.com/textbook/semiconductors/chpt-7/field-effectcontrolled-thyristors/>
4. <https://www.electrical4u.com/applications-of-op-amp/>
5. <https://www.geeksforgeeks.org/digital-electronics-logic-design-tutorials/>

ELECTRONICS I
(Course Code: 26PPHC14)

PRACTICALS-I (Any Eight experiments)

Semester I	Core 4	Hours 4	Credits 2
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List of Experiments:

1. Determine the V–I characteristics of a Silicon Controlled Rectifier and verify its triggering behavior.
2. Construct a Schmitt trigger using the IC555 timer and verify hysteresis action.
3. Perform network analysis using Thevenin's and Norton's theorems to determine equivalent circuits.
4. Construct a BJT amplifier and determine its voltage gain and frequency response.
5. Design an instrumentation amplifier using operational amplifiers and verify its performance.
6. Create an average amplifier using op-amps and determine its output response.
7. Verify the differential amplifier's common-mode gain, differential-mode gain, and calculate CMRR.
8. Develop a Wien's bridge oscillator using op-amps and verify its frequency of oscillation.
9. Create pulse and astable multivibrators using op-amps and determine their timing characteristics.
10. Solve simultaneous equations using op-amp based analog computation circuits.
11. Develop a triangular wave generator using op-amps and verify waveform output.
Construct active filters (low-pass, high-pass, band-pass) using op-amps and determine their frequency response.

COMMUNICATION ELECTRONICS
(Course Code: 26PPHE11)

Semester I	Elective 1	Hours 4	Credits 4
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Course Outcomes: At the end of the course the students must be able to

CO1 To comprehend the transmission of electromagnetic waves through different types of antenna (K1)

CO2 To acquire knowledge about the propagation of waves through earth's atmosphere and along the surface of the earth (K2)

CO3 To gain knowledge in the generation and propagation of microwaves (K3)

CO4 To acquire knowledge about radar systems and its applications and also the working principle of colour television (K4)

CO5 To learn the working principle of fiber optics and its use in telecommunication (K5)

CO6 To understand the general theory and operation of satellite communication systems (K6)

UNIT I: ANTENNAS AND WAVE PROPAGATION (12 HOURS)

Radiation field and radiation resistance of short dipole antenna-grounded antenna- ungrounded antenna- antenna gain- antenna arrays- broad side and end – fire arrays - directional high frequency antennas-UHF and Microwave antennas- - Sky wave-ionosphere –Effect of Earth's magnetic field – Extraterrestrial communication – ground wave propagation.

UNIT II: MICROWAVES (12 HOURS)

Multicavity Klystron– Reflex Klystron – Magnetron – Travelling wave tubes (TWT) – Other microwave tubes - Crossed field amplifier and Backward – Wave Oscillator – Fundamentals of MASER – Fundamentals of operation – the Ruby MASER – Practical MASERS and their applications .

UNIT III: SATELLITE COMMUNICATION (12 HOURS)

Kepler's First, Second and Third laws – Orbits – Geostationary satellites – Satellite system parameters – Power systems – Attitude control – Satellite station keeping – Antenna look angles – Determination of elevation angle – Limits of visibility – Frequency plans and polarization — Uplink power budget calculations – Downlink power budget calculations – Overall link budget calculations.

UNIT IV: OPTICAL FIBER (12 HOURS)

Importance of optic fiber- propagation of light wave in optical fiber- acceptance angle and acceptance cone of a fiber- numerical aperture- Principles of Light Transmission in a Fiber - Losses in Fibers – Dispersion - Light Sources for Fiber Optics, Photo-detectors, Fiber-optic Communication Link.

UNIT V: MOBILE COMMUNICATION (12 HOURS)

Need for Mobile communication – Requirements of mobile communication – History of mobile communication – Properties of wireless medium – Radio propagation – Reflection, scattering and diffraction in propagation – Propagation coverage calculations –Cellular structure – Frequency reuse – Mobile internet– Working of mobile IP

BOOKS FOR STUDY:

1. Electronic Communications, Dennis Roddy, John Coolen, Fourth edition, Pearson, (2014).
2. Wireless and mobile communication, T.G.Palanivelu, R.Nakkeeran, Prentice Hall India.

3. Electronic communication systems – George Kennedy and Davis, Tata McGraw Hill, 4th edition, 1988.

BOOKS FOR REFERENCE

1. Wayne Tomasi, Advanced electronics communication systems, fourth edition, Prentice Hall of India, 1998
2. S. Salivahanan, N. Suresh Kumar & A. Vallavaraj, 2009, Electronic Devices and Circuits, Tata McGraw-Hill Publishing Company Limited, New Delhi, Second Edition.
3. Taub and Schilling, principles of communication systems, second edition, Tata McGraw Hill (1991).

WEB SOURCES

1. <https://www.geeksforgeeks.org/digital-electronics-logic-design-tutorials/>
2. <https://www.polytechnichub.com/difference-analog-instruments-digital-instruments/>
3. <http://nptel.iitm.ac.in/>
4. <http://web.ewu.edu/>
5. <http://nptel.iitm.ac.in/>

ASTRO PHYSICS
(Course Code: 26PPHE11)

Semester I	Elective 1	Hours 4	Credits 4
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Course Outcomes: At the end of the course the students must be able to

CO1 To impart knowledge on the physical universe and its evolution. (K1)

CO2 To make the student understand fundamental principles and techniques of astronomy and astrophysics. (K2)

CO3 To make the student study electromagnetic radiation from stars, atomic spectra and classification of stars. (K3)

CO4 To provide information about the properties and the evolution of stars. (K4)

CO5 To render information about astronomical instrumentation. (K5)

CO6 To apply the concepts and relations in understanding the galaxies (K6)

UNIT I : OBSERVATIONAL ASTRONOMY AND THE CONTRIBUTION OF INDIANS TO KNOWLEDGE SYSTEM (12 HOURS)

Electromagnetic spectrum – Reflection and Refraction – Diffraction and Interference – Quantum nature of light – Reflecting telescopes – Refracting Telescope – Radio telescope – Importance of Ancient Indian Contributions- Contribution to Maths, Physics and Astronomy.

UNIT II : PROPERTIES OF STARS (12 HOURS)

Stellar luminosity – Stellar Distances – Absolute magnitude scale – Color and surface temperature – stellar spectra-spectroscopic parallax- Hertzsprung–Russell diagram – Size – Direct measurement, Masses and densities of Stars – Stellar mass luminosity relationship – Stellar lifetime.

UNIT III : THE LIFE AND DEATH OF STARS (12 HOURS)

Low mass stars - Mid mass stars-moving up main sequence – triple alpha process – planetary nebula – white dwarfs – discovery, future and black dwarfs – The evolution of sun-like star- high mass stars – Type II supernova- Crab Nebula – black holes

UNIT IV : GALAXIES (12HOURS)

The Milky Way Galaxy – spiral structure – galactic center – normal galaxies – Types of galaxies- elliptical – spiral – other galaxies – star formation in galaxies – explanation of spiral structure – Dark matter in galaxies – cluster of galaxies – distribution and cluster dynamics

UNIT V : COSMOLOGY (12 HOURS)

The steady state model of the universe – Big bang – The cosmic microwave background – Formation of the primeval elements - Ripples in the cosmic microwave – Impact of Dark matter – hidden universe – dark matter and dark energy

BOOKS FOR STUDY

1. Zeilik& Gregory, Introductory Astronomy & Astrophysics, 4th Publishing)
2. Morison, I., Introduction to Astronomy and Cosmology, (Wiley)
3. Kutner, M.L., Astronomy: A Physical Perspective (Cambridge University Press)
4. Green, S.F. & Jones, M. H., An Introduction to the Sun and Stars (Cambridge University Press)

BOOKS FOR REFERENCE

1. Jones, M.H. & Lambourne, R.J.A., An Introduction to Galaxies & Cosmology (Cambridge University Press)
2. Carroll, B.W. & Ostlie, D.A., An Introduction to Modern Astrophysics (Pearson)
3. Shu, F.H., The Physical Universe, An Introduction to Astronomy, (University Science Books)
4. Motz, L. & Duveen, A., The Essentials of Astronomy, (Colombia University Press)

WEB SOURCES

1. Indian-Knowledge-System- <https://share.google/4yeZFBgF76U19AOLY>
2. Scientific Contributions From Ancient India: A Review Of Knowledge Systems -<https://ilkogretim-online.org/index.php/pub>
3. <https://acr-journal.com/article/contribution-of-physics-to-ancient-indian-knowledge-system-1808/>
4. <https://www.granthaalayahpublication.org/journals/granthaalayah/article/view/6157/6003>
5. <https://spaceplace.nasa.gov/solar-activity/en>

GENERAL PHYSICS EXPERIMENTS – I

(Course Code: 26PPHE12)

PRACTICALS–II (Any Eight experiments)

Semester I	Elective 2	Hours 4	Credits 2
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List of Experiments:

1. Determination of Rydberg's constant–Hydrogen spectrum
2. Determination of elastic constant–Elliptical fringes
3. XRD–Indexing of X–Ray diffraction pattern
4. Determination of elastic constant–Hyperbolic fringes
5. Determination of the wavelength using He-Ne laser
6. Determination of Solar constant
7. Determination of Cauchy's constant using spectrometer
8. Verification of i – d curve using spectrometer
9. Determination of Planck's constant using LED
10. Determination of refractive index of different liquids using spectrometer
11. Determination of fiber optic loss
12. Diffraction of light using double slit experiment

STATISTICAL MECHANICS
(Course Code: 26PPHC21)

Semester II	Core 5	Hours 6	Credits 5
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Course Outcomes: At the end of the course the students must be able to

- CO1** Apply the laws of thermodynamics to analyze energy transfer, heat engines, entropy, and equilibrium processes in physical systems (K1)
- CO2** Understand the fundamental concepts of statistical mechanics and their applications to physical systems. (K2)
- CO3** Analyze ensembles such as microcanonical, canonical, and grand canonical ensembles in describing macroscopic systems. (K3)
- CO4** Explain the statistical basis of thermodynamics and relate microscopic particle behavior to macroscopic physical properties. (K4)
- CO5** Develop the knowledge about phase transitions and fluctuation of thermodynamic properties that vary with time (K5)
- CO6** Create the problem-solving skills in statistical distributions, phase transitions, and thermodynamic equilibrium phenomena (K6)

UNIT I: THERMODYNAMICS (18 HOURS)

Postulates of thermodynamics - Energy and first law of thermodynamics - entropy and second law of thermodynamics – Principle of increase of entropy – thermodynamic potentials – thermodynamic equilibrium – Clausius-Clapeyron equation - Nernst's heat theorem – consequences of third law – chemical potential.

UNIT II: STATISTICAL MECHANICS AND ENSEMBLES (18 HOURS)

Phase space - law of equipartition of energy - Ensembles - Micro canonical ensemble - – ideal gas using the micro canonical ensemble - Entropy of mixing and Gibb's paradox- - Canonical and grand canonical ensembles - Partition function - Thermodynamic properties of monoatomic and diatomic ideal gas.

UNIT III: QUANTUM STATISTICS (18 HOURS)

Statistics of ensembles - Maxwell-Boltzmann statistics – Bose-Einstein statistics - Fermi-Dirac statistics – Ideal Fermi gas – Degeneracy – Planck radiation formula- Ideal Bose gas - Bose-Einstein condensation-- Einstein's theory of specific heat- Debye's theory of specific heat capacity.

UNIT IV: TRANSPORT THEORY AND FLUCTUATIONS (18 HOURS)

Cluster expansion for a classical gas - Virial equation of state – Calculation of the first Virial coefficient in the cluster expansion - Ising model - Fluctuations and transport phenomena – Fluctuations in ensembles – Probability of random walk in one dimension - Brownian motion - Langevin's theory - The Fokker-Planck equation

UNITV: PHASETRANSITIONS**(18 HOURS)**

Phase Equilibrium - Gibb's phase rule –Triple point –Vanderwall's equation - I and II order Phase transitions -Ehrenfest's –Order parameters – Landau's theory of phase transition- Scale transformations and dimensional analysis.

BOOK FOR STUDY:

1. Satya Prakash, Statistical Mechanics, Kedarnath Ramnath, New Delhi 2008
2. Francis W Sears and Gerhard L. Salinger, Thermodynamics, kinetic theory and statistical thermodynamics, 3rd edition, Narosa Publishing house.
3. S.K. Sinha, 1990, Statistical Mechanics, Tata McGraw Hill, New Delhi.
4. B.K. Agarwal and M. Eisner, 1998, Statistical Mechanics, Second Edition New Age International, New Delhi.
5. J.K. Bhattacharjee, 1996, Statistical Mechanics: An Introductory Text, Allied Publication, New Delhi.

BOOK FOR REFERENCE

1. Pathria, 1996, Statistical Mechanics, 2nd edition, Butter Worth Heinemann, New Delhi.
2. L.D. Landau and E.M. Lifshitz, 1969, Statistical Physics, Pergamon Press, Oxford.
3. K. Huang, 2002, Statistical Mechanics, Taylor and Francis, London
4. W. Greiner, L. Neise and H. Stoecker, Thermodynamics and Statistical Mechanics, Springer Verlag, New York.
5. A.B. Gupta, H. Roy, 2002, Thermal Physics, Books and Allied, Kolkata.
6. F. Reif, 1965, Fundamentals of Statistical and Thermal Physics, McGraw-Hill, New York.
7. M.K. Zemansky, 1968, Heat and Thermodynamics, 5th edition, McGraw-Hill New York.

WEB SOURCES

1. <https://byjus.com/chemistry/third-law-of-thermodynamics/>
2. <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_mod

QUANTUM MECHANICS - I
(Course Code: 26PPHC22)

Semester II	Core 6	Hours 6	Credits 5
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Course Outcomes: At the end of the course the students must be able to

CO1: To develop the physical principles and the mathematical background important to quantum mechanical descriptions (K1)

CO2: To describe the propagation of a particle in a simple, one-dimensional potential (K2)

CO3: To formulate and solve the Schrodinger's equation to obtain eigenvectors and energies for particle in a three-dimensional potential (K3)

CO4: To explain the mathematical formalism and the significance of constants of motion, and see their relation to fundamental symmetries in nature (K4)

CO5: To discuss the Approximation methods like perturbation theory, Variational and WKB methods for solving the Schrödinger equation (K5)

CO6: To develop quantum mechanical models for solving classical problems in physics (K6)

UNIT I: BASIC FORMALISM (18 HOURS)

Interpretation of the wave function – Time dependent Schrodinger equation – Time independent Schrodinger equation – Stationary states – Ehrenfest's theorem – Linear vector space – Linear operator – Eigen functions and Eigen Values – Hermitian Operator – Postulates of Quantum Mechanics – Simultaneous measurability of observables – General Uncertainty relation

UNIT II : ONE DIMENSIONAL AND THREE-DIMENSIONAL ENERGY EIGEN VALUE PROBLEMS (18 HOURS)

Square – well potential with rigid walls – Square well potential with finite walls – Square potential barrier – Alpha emission – Linear harmonic oscillator: Operator method – Particle moving in a spherically symmetric potential – Hydrogen atom – Rigid rotator

UNIT III: GENERAL FORMALISM (18 HOURS)

Dirac notation – Equations of motions – Schrodinger representation – Heisenberg representation – Interaction representation – Momentum representation – Unitary transformation – Symmetry transformation – Space inversion: Parity conservation- time reversal

UNIT IV: APPROXIMATION METHODS (18 HOURS)

Time independent perturbation theory for non-degenerate energy levels – Degenerate energy levels – Stark effect in Hydrogen atom – Ground and excited state – Variation method – WKB approximation – Connection formulae (no derivation) – Validity of WKB method – Application to simple harmonic oscillator.

UNIT V: ANGULAR MOMENTUM (18 HOURS)

Angular momentum operators-Angular momentum commutation relations-General angular momentum – Eigen values of J^2 and J_z - Angular momentum matrices - Spin angular momentum – Addition of angular momenta – Clebsch Gordan Coefficients .

BOOKS FOR STUDY

1. P.M. Mathews and K.Venkatesan, A Textbook of Quantum Mechanics, 2nd Edition (37th Reprint), Tata McGraw–Hill, New Delhi, 2010.
2. G. Aruldas, Quantum Mechanics, 2nd Edition, Prentice Hall of India, New Delhi, 2009.
3. David J Griffiths, Introduction to Quantum Mechanics. 4th Edition, Pearson, 2011.
4. S L Gupta and I D Gupta, Advanced Quantum Theory and Fields, 1st Edition, S.Chand & Co., New Delhi, 1982.
5. Ghatak and S. Lokanathan, Quantum Mechanics: Theory and Applications, 4th Edition, Macmillan, India, 1984.
6. Satya Prakash, Swati Shaluja, Quantum Mechanics, Kedar Nath Ram Nath & Co Publishers, Meerut, India.

BOOKS FOR REFERENCE

1. E. Merzbacher, Quantum Mechanics, 2nd Edition, John Wiley and Sons, New York, 1970.
2. V. K. Thankappan, Quantum Mechanics, 2nd Edition, Wiley Eastern Ltd, New Delhi, 1985.
3. L.D. Landau and E.M.Lifshitz, Quantum Mechanics, 1st Edition, Pergamon Press, Oxford, 1976.
4. S.N.Biswas, Quantum Mechanics, Books and Allied Ltd., Kolkata, 1999.
5. V. Devanathan, Quantum Mechanics, 2nd edition, Alpha Science, International Ltd, Oxford, 2011.

WEB SOURCES

1. http://research.chem.psu.edu/lxjgroup/download_files/chem565-c7.pdf
2. http://www.feynmanlectures.caltech.edu/III_20.html
3. <http://web.mit.edu/8.05/handouts/jaffe1.pdf>
4. https://hepwww.pp.rl.ac.uk/users/haywood/Group_Theory_Lectures/Lecture_1.pdf
5. <https://theory.physics.manchester.ac.uk/~xian/qm/chapter3.pdf>

CONDENSED MATTER PHYSICS
(Course Code: 26PPHC23)

Semester II	Core 7	Hours 6	Credits 5
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Course Outcomes: At the end of the course the students must be able to

CO1 Remember and determine different crystal structures of materials and Provide in– depth knowledge of the structure of solids. (K1)

CO2 Understand the knowledge on the theory of lattice vibration and correlate it with material thermal Properties. (K2)

CO3 Apply the knowledge level from theoretical physical subjects towards the understanding of basic properties of solid state matter. (K3)

CO4 Analyse the magnetic properties of material and predict magnetic properties of atoms and molecules based on their electronic configurations. (K4)

CO5 Evaluate the applications of superconductors in the cryogenics and industry.(K5)

CO6 Create the basic knowledge and also give an overview of current problems within the field of condensed matter/materials science mainly on functional materials. (K6)

UNIT I: CRYSTAL PHYSICS (18 HOURS)

Types of lattices - Miller indices – Symmetry elements and allowed rotations - Simple crystal structures – Atomic Packing Factor- Crystal diffraction - Bragg's law – Scattered Wave Amplitude - Packing density - hcp and ccp; Reciprocal Lattice (sc, bcc, fcc). Structure and properties of liquid crystals. Diffraction Conditions - Laue equations - Brillouin zone – Structure factor - Atomic form factor - Inert gas crystals - Cohesive energy of ionic crystals – Madelung constant- Types of crystal binding (general ideas).

UNIT II: LATTICE DYNAMICS (18 HOURS)

polaron– vibrations of one dimensional monoatomic and diatomic linear lattices -Group and phase velocities – Quantization of lattice vibrations – Phonon momentum – Inelastic scattering by phonons – Debye’s theory of lattice heat capacity – Thermal Conductivity –Umkalapp processes.

UNIT III: THEORY OF METALS AND SEMICONDUCTORS (18 HOURS)

Free electron gas in three dimensions – Electron heat capacity-Electric and thermal conductivities – Wiedemann–Franz law – Band theory of solids – Bloch theorem –Kronig–Penney model – Semiconductors – Fermi distribution function – Intrinsic carrier concentration –Temperature Dependence – Mobility and conductivity in semiconductors – Hall effect – Fermi surfaces and Construction in metals – De-Hass-van Alphen effect.

UNIT IV: MAGNETISM (18 HOURS)

Diamagnetism - Quantum theory of paramagnetism- Hund’s rule- Quantum theory of ferromagnetism - Curie point - Quenching of orbital angular momentum – Adiabatic

demagnetization- Exchange integral – Heisenberg's interpretation of Weiss field – Ferromagnetic domains - Bloch wall - Spin waves - Quantization - Magnons - Thermal excitation of magnons - Curie temperature and susceptibility of ferrimagnets - Theory of anti ferromagnetism – Neel temperature.

UNIT V: SUPERCONDUCTIVITY

(18 HOURS)

Effect of magnetic fields - Critical field- Meissner effect – Entropy and heat capacity - Energy gap - Type I and II Superconductors. London equation – Theoretical Explanation: Thermodynamics of super conducting transition- Coherence length – Isotope effect - Cooper pairs – Bardeen Cooper Schrieffer (BCS) Theory- Single particle tunneling - Josephson tunneling - DC and AC Josephson effects - High temperature Superconductors – SQUIDS.

BOOKS FOR STUDY

1. S.O. Pillai, Problems and Solutions in Solid State Physics, New Age international Publishers, New Delhi, 1994.
2. Rita John, Solid State Physics, Tata Mc Graw Hill Publications, 2014.
3. M. A. Wahab, Solid State Physics – Structure and Properties of Materials. Narosa, New Delhi, 1999.
4. J.D. Patterson, B.C. Bailey Solid-State Physics: Introduction to the Theory, Springer Publications, 2007.
5. M. Ali Omar, Elementary Solid State Physics – Principles and Applications, Pearson, 1999.
6. H. P. Myers, 1998, Introductory Solid State Physics, 2nd Edition Viva Book, New Delhi.
7. R.K.Puri, V.K. Babbar, Solid state physics, 1st Edition S.Chand & company LTD, New Delhi.

BOOKS FOR REFERENCE

1. Charles Kittel, Introduction to Solid State Physics, 7th Edition, Wiley India Pvt. Ltd. , New Delhi, 2004.
2. M. Tinkham, Introduction to Superconductivity, Tata Mcgraw Hill, New Delhi, 1996.
3. J. S. Blakemore, 1974, Solid state Physics, 2nd Edition, W.B. Saunder, Philadelphia
4. H. M. Rosenberg, 1993, The Solid State, 3rd Edition, Oxford University Press, Oxford.
5. J. M. Ziman, 1971, Principles of the Theory of Solids, Cambridge University Press, London.
6. C. Ross-Innes and E. H. Rhoderick, 1976, Introduction to Superconductivity, Pergamon, Oxford.
7. J. P. Srivastava, 2001, Elements of Solid State Physics, Prentice-Hall of India, New Delhi.

MEDICAL PHYSICS
(Course Code: 26PPHE21)

Semester II	ELECTIVE 2	Hours 4	Credits 3
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COURSE OUTCOMES: At the end of the course the students must be able to

CO1 Learn the fundamentals, production and applications of X-rays (K1)

CO2 Understand the basics of blood pressure measurements, Learn about sphygmomanometer, ECG, ENG and basic principles of MRI (K2)

CO3 Apply knowledge on Radiation Physics (K3)

CO4 Analyse Radiological imaging and filters (K4)

CO5 Assess the principles of radiation protection (K5)

CO6 Create and develop instruments (K6)

UNIT I: X-RAYS AND TRANSDUCERS (12 HOURS)

Electromagnetic Spectrum – Production of X-Rays – X-Ray Spectrum – Bremsstrahlung – Characteristic X-Ray – X-Ray Tubes – Coolidge Tube – X-Ray Tube Design – Thermistors – photo electric transducers – Photo voltaic cells – photo emissive cells – Photoconductive cells – piezoelectric transducer

UNIT II: BLOOD PRESSURE MEASUREMENTS (12 HOURS)

Introduction – sphygmomanometer – Measurement of heart rate – basic principles of electrocardiogram (ECG) – Basic principles of electro-neurography (ENG) – Basic principles of magnetic resonance imaging (MRI).

UNIT III: RADIATION PHYSICS (12 HOURS)

Radiation Units – Exposure – Absorbed Dose – Rad to Gray – KERMA – Relative Biological Effectiveness – Effective Dose – Sievert (Sv) – Inverse Square Law – Interaction of radiation with Matter – Linear Attenuation Coefficient – Radiation Detectors – Thimble Chamber – Geiger Counter – Scintillation Counter

UNIT IV: MEDICAL IMAGING PHYSICS (12 HOURS)

Radiological Imaging – Radiography – Filters – Grids – Cassette – X-Ray Film – Film processing – Fluoroscopy – Computed Tomography Scanner – Principal Function – Display – Mammography – Ultrasound Imaging – Gamma Camera (Only Principle, Function and display)

UNIT V: RADIATION PROTECTION (12 HOURS)

Principles of Radiation Protection – Protective Materials – Radiation Effects – Somatic – Genetic Stochastic and Deterministic Effect – Personal Monitoring Devices – TLD Film Badge – Pocket Dosimeter

BOOKSFORSTUDY:

1. Dr.K.Thayalan, Basic Radiological Physics, Jayapee Brothers Medical Publishing Pvt. Ltd. New Delhi, 2003.
2. Curry, Dowdey and Murry, Christensen's Physics of Diagnostic Radiology:- Lippincott Williams and Wilkins, 1990.
3. FM Khan, Physics of Radiation Therapy, William and Wilkins, 3rd ed, 2003.
4. D.J.Dewhurst, An Introduction to Biomedical Instrumentation, 1st ed, Elsevier Science, 2014.
5. R.S. Khandpur, Hand Book of Biomedical Instrumentations, 1st ed, TMG, New Delhi, 2005.

BOOKSFORREFERENCE:

1. Muhammad Maqbool, An Introduction to Medical Physics, 1st ed, Springer International Publishing, 2017.
2. Daniel Jiráček, František Vítek, Basics of Medical Physics, 1st ed, Charles University, Karolinum Press, 2018
3. Anders Brahme, Comprehensive Biomedical Physics, Volume 1, 1st ed, Elsevier Science, 2014.
4. K.Venkata Ram, Bio-Medical Electronics and Instrumentation, 1st ed, Galgotia Publications, New Delhi, 2001.
5. John R.Cameron and James G.Skofronick, 2009, Medical Physics, John Wiley Inter science Publication, Canada, 2nd edition.

WEB SOURCES

1. <https://nptel.ac.in/courses/108/103/108103157/>
2. <https://www.studocu.com/en/course/university-of-technology-sydney/medical-devices-and-diagnostics/225692>
3. https://www.technicalsymposium.com/alllecturenotes_biomed.html
4. <https://lecturenotes.in/notes/17929-note-for-biomedical-instrumentation-bi-by-deepraj-adhikary/78>
5. <https://www.modulight.com/applications-medical/>

SOLAR ENERGY UTILIZATION

(Course Code: 26PPHE21)

Semester II	ELECTIVE 2	Hours 4	Credits 3
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Course Outcomes: At the end of the course the students must be able to

- CO1** To impart fundamental aspects of solar energy utilization. (K1)
- CO2** To give adequate exposure to solar energy related industries (K2)
- CO3** To harness entrepreneurship skills (K3)
- CO4** To understand the different types of solar cells and channelizing them to the different sectors of society (K4)
- CO5** To develop an industrialist mindset by utilizing renewable source of energy (K5)
- CO6** Create and develop photovoltaic devices (K6)

UNIT I: HEAT TRANSFER & RADIATION ANALYSIS (12 HOURS)

Conduction, Convection and Radiation – Solar Radiation at the earth's surface - Determination of solar time – Solar energy measuring instruments.

UNIT II: SOLAR COLLECTORS (12 HOURS)

Physical principles of conversion of solar radiation into heat flat plate collectors - General characteristics – Focusing collector systems – Thermal performance evaluation of optical loss.

UNIT III: SOLAR HEATERS (12 HOURS)

Types of solar water heater - Solar heating system – Collectors and storage tanks – Solar ponds – Solar cooling systems.

UNIT V: SOLAR ENERGY CONVERSION (12 HOURS)

Photo Voltaic principles – Types of solar cells – Crystalline silicon/amorphous silicon and Thermo - electric conversion - process flow of silicon solar cells - different approaches on the process - texturization, diffusion, Antireflective coatings, metallization.

UNIT V: NANO MATERIALS IN FUEL CELL APPLICATIONS

(12 HOURS)

Use of nanostructures and nanomaterials in fuel cell technology - high and low temperature fuel cells, cathode and anode reactions, fuel cell catalysts, electrolytes, ceramic catalysts. Use of Nano technology in hydrogen production and storage.

BOOKS FOR STUDY:

1. G.D. Rai, Solar energy utilization – Khanna publishers – Delhi 1987.
2. B.H. Khan, Non Conventional Energy Resources, 3rd edn, McGraw Hill Education India Private Limited, 2017.
3. Maheshwar Sharon, Madhuri Sharon, Carbon “ Nano forms and Applications”, McGraw-Hill, 2010.
4. Soteris A. Kalogirou, Solar Energy Engineering: Processes and Systems, Academic Press, London, 2009
5. Tiwari G.N, “Solar Energy–Fundamentals Design, Modelling and applications, Narosa Publishing House, New Delhi, 2002
6. Sukhatme S.P. Solar Energy, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997.

BOOKS FOR REFERENCE:

1. Energy–An Introduction to Physics–R.H. Romer, W.H. Freeman. (1976)

2. Solar energy thermal processes–John A. Duffie and William A. Beckman. (1974)
3. John W. Twidell & Anthony D. Weir, 'Renewable Energy Resources, 2005
4. John A. Duffie, William A. Beckman, Solar Energy: Thermal Processes, 4th Edition, John Wiley and Sons, 2013
5. Duffie, J.A., Beckman, W.A., "Solar Energy Thermal Process", John Wiley and Sons, 2007.

ELECTRONICS II
(Course Code: 26PPHE22)

PRACTICALS–III (Any Eight experiments)

Semester II	Elective 3	Hours 4	Credits 2
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1. Determine the design of a Binary Coded Decimal adder and subtractor circuit.
2. Verify De Morgan's theorems using truth tables and Karnaugh map simplification.
3. Determine the conversion of BCD inputs to 7-segment display outputs and verify digit representation.
4. Determine the operation of shift registers in serial-in/serial-out and parallel-in/parallel-out modes.
5. Verify the design and operation of an up–down counter circuit.
6. Determine the working of a mod-counter and verify its counting sequence.
7. Verify the operation of a ring counter and determine its applications.
8. Determine the design of a binary adder and subtractor circuit and verify its truth table.
9. Determine the operation of multiplexer and demultiplexer circuits.
10. Verify the working of encoder and decoder circuits.
11. Determine the design of parity generator and checker circuits for error detection.
12. Verify arithmetic and logic operations using the 74181 ALU IC.

GENERAL PHYSICS EXPERIMENTS – II

(Course Code : 26PPHS21)

PRACTICALS–IV (Any Eight experiments)

Semester II	Elective 4	Hours 4	Credits 2
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1. Determination of band gap of thin films using Fourprobe method
2. Determination of Magnetic susceptibility using Guoy's method
3. Determination of magnetoresistance of a semiconductor
4. Calculation of Dielectric constant of crystals using Parallel plate capacitor method
5. Measurement of Dielectric constant of liquids using Colpitts oscillator
6. Determination of Magnetic susceptibility by Quincke's method
7. Measurement of Hall voltage and Hall coefficient using Hall Probe apparatus
8. Measurement of dielectric constant by LCR method
9. Determination of Energy Bandgap using four Probe method
10. Measurement of Conductivity of semiconductor crystal using Two probe method
11. Determination of dielectric loss using CRO
12. Determination of velocity of sound by Ultrasonic Interferometer

QUANTUM MECHANICS - II
(Course Code: 26PPHC31)

Semester III	Core 8	Hours 6	Credits 6
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Course Outcomes: At the end of the course the students must be able to

- CO1:** To develop the theory and the properties of angular momenta, both orbital and spin (K1)
- CO2:** To familiarize the students to the crucial concepts of scattering theory such as partial wave analysis and Born approximation. (K2)
- CO3:** To explain Time-dependent Perturbation theory and its application to study of interaction of an atom with the electromagnetic field (K3)
- CO4:** To give the students a firm grounding in relativistic quantum mechanics, with emphasis on Dirac equation and related concepts (K4)
- CO5:** To introduce the concept of covariance and the use of Feynman graphs for depicting different interactions (K5)
- CO6:** Develop the concepts related to Bosons (K6)

UNIT I: PERTURBATION THEORY (18 HOURS)

Time dependent perturbation theory – First order perturbation – Harmonic perturbation – Transition to continuum states – Transition probability – Einstein's A and B Coefficients – Adiabatic approximation – Sudden approximation – Application of time dependent perturbation theory to Semi classical theory of radiation – Selection rules.

UNIT II: SCATTERING THEORY (18 HOURS)

Scattering cross section – Scattering amplitude – Partial waves – Scattering by a central potential: Partial wave analysis- optical theorem- Scattering length- The Born approximation – Scattering by screened coulomb potential – Validity of Born approximation- Yukawa potential – Laboratory and centre of mass coordinate systems.

UNIT III: RELATIVISTIC QUANTUM MECHANICS (18 HOURS)

Klein – Gordon Equation Particle in a Coulomb field – Dirac Equation for a free particle- Dirac Matrices – Covariant form of Dirac Equation - Negative Energy States – Antiparticles – Spin of the Dirac particle – Magnetic Moment of an Electron

UNIT IV: IDENTICAL PARTICLES AND SPIN (18 HOURS)

Indistinguishable particles- Particle exchange operator- Symmetric and antisymmetric wave functions- Pauli's exclusion principle - Spin angular momentum- spin matrices for electron - commutation relations - Pauli Eigen values and Eigen functions - Electron spin functions- Spin matrices and Eigen functions – Density operator and density matrix - spin functions for two electrons and three electrons.

UNIT V: CLASSICAL FIELDS AND SECOND QUANTIZATION (18 HOURS)

Classical field equation: Lagrange form – Hamiltonian form – Quantization of the field – The N-representation- System of Bosons – Creation and Annihilation operators – System of fermions – The Klein Gordon field.

BOOKS FOR STUDY

1. P.M. Mathews and K.Venkatesan, A Textbook of Quantum Mechanics, 2nd Edition (37th Reprint), Tata McGraw–Hill, New Delhi, 2010.
2. G.Aruldas, Quantum Mechanics, 2nd Edition , Prentice Hall of India, New Delhi, 2009.
3. L.I. Schiff, Quantum Mechanics, 3rd Edition, International Student Edition, McGraw-Hill Kogakusha, Tokyo, 1968
4. V. Devanathan, Quantum Mechanics, 1st Edition, Narosa Publishing House, New Delhi, 2005.
5. Nouredine Zettili, Quantum Mechanics concepts and applications, 2nd Edition, Wiley, 2017
6. Satya Prakash, Swati Shaluja, Quantum Mechanics, Kedar Nath Ram Nath & Co Publishers, Meerut, India.

BOOKS FOR REFERENCE

1. P. A. M. Dirac, The Principles of Quantum Mechanics, 4th Edition, Oxford University Press, London, 1973.
2. B.K.Agarwal & Hari Prakash, Quantum Mechanics, 7th Reprint, PHI Learning Pvt.Ltd., New Delhi, 2009.
3. Deep Chandra Joshi, Quantum Electrodynamics and Particle Physics, 1st Edition, I.K. International Publishing House Pvt. Ltd., 2006
4. Ghatak and S.Lokanathan, Quantum Mechanics: Theory and Applications, 4th Edition, Macmillan India, New Delhi.
5. E. Merzbacher, Quantum Mechanics, 2nd Edition, John Wiley and Sons, New York, 1970

WEB SOURCES

1. https://ocw.mit.edu/courses/physics/8-05-quantum-physics-ii-fall-2013/lecturenotes/MIT8_05F13_Chap_09.pdf
2. http://www.thphys.nuim.ie/Notes/MP463/MP463_Ch1.pdf
3. <http://hep.itp.tuwien.ac.at/~kreuzer/qt08.pdf>
4. <https://www.cmi.ac.in/~govind/teaching/rel-qm-rc13/rel-qm-notes-gk.pdf>
5. <https://web.mit.edu/dikaizer/www/FdsAmSci.pdf>

ELECTROMAGNETIC THEORY
(Course Code: 26PPHC32)

Semester III	Core 9	Hours 6	Credits 6
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Course Outcomes: At the end of the course the students must be able to

CO1 Remember the fundamentals of Maxwell equations (K1)

CO2 Understand the electric and magnetic fields (K2)

CO3 Apply the theory to solve problems in electromagnetic field (K3)

CO4 Analyze the behaviour in Electromagnetic waves (K4)

CO5 Evaluate the electrostatic boundary value (K5)

CO6 Develop the knowledge about waveguides (K6)

UNIT I: ELECTROSTATICS

(18HOURS)

Electric charge - Coulombs Law - Electric field-Electrostatic potential - Gauss Law - Applications of Gauss Law - Electric dipole - Multipole Expansion of Electric fields - Poisson's Equation - Laplace Equation - Polarization - Field outside a dielectric medium - The Electric field inside a Dielectric - Gauss Law in Dielectric - The Electric displacement - Electric susceptibility and dielectric constant

UNIT II: MAGNETOSTATICS

(18HOURS)

Biot-Savart's Law - Ampere's law - Magnetic vector potential and magnetic field of a localized current distribution - Magnetic moment, force and torque on a current distribution in an external field - Magneto static energy - Magnetic induction and magnetic field in macroscopic media - Boundary conditions - Uniformly magnetized sphere.

UNIT III: MAXWELL'S EQUATION

(18HOURS)

Faraday's laws of Induction - Maxwell's displacement current - Maxwell's equations in matter - Gauge invariance - Wave equation and plane wave solution - Energy and momentum of the field - Poynting's theorem - Lorentz force

UNIT IV: WAVE PROPAGATION

(18HOURS)

Plane waves in non-conducting media - Linear and circular polarization, reflection and refraction at a plane interface - Waves in a conducting medium - Propagation of waves in a rectangular wave guide - Inhomogeneous wave equation and retarded potentials - Radiation from a localized source - Oscillating electric dipole

UNIT V: POTENTIALS AND FIELDS

(18HOURS)

The potential formulation - Scalar and Vector Potentials - Gauge Transformation - Coulomb Gauge and Lorentz Gauge - Lorentz force law in potential form-continuous distributions-retarded potentials - Jefimenko's equations - point charge - LienardWiechert potentials.

BOOKSFORSTUDY:

1. D.J. Griffiths, 2002, Introduction to Electrodynamics, 3rd Edition, Prentice-Hall of India, New Delhi.
2. J.R. Reitz, F.J. Milford and R.W. Christy, 1986, Foundations of Electromagnetic Theory, 3rd edition, Narosa Publishing House, New Delhi.
3. J.D. Jackson, 1975, Classical Electrodynamics, Wiley Eastern Ltd. New Delhi.
4. J.A. Bittencourt, 1988, Fundamentals of Plasma Physics, Pergamon Press, Oxford.
5. Gupta, Kumar and Singh, Electrodynamics, S.Chand & Co., New Delhi

BOOKSFORREFERENCE:

1. W. Panofsky and M. Phillips, 1962, Classical Electricity and Magnetism, Addison Wesley, London.
2. J.D. Kraus and D.A. Fleisch, 1999, Electromagnetics with Applications, 5th WCB McGraw-Hill, New York.
3. B. Chakraborty, 2002, Principles of Electrodynamics, Books and Allied, Kolkata. Edition,
4. P. Feynman, R.B. Leighton and M. Sands, 1998, The Feynman Lectures on Physics, Vols. 2, Narosa Publishing House, New Delhi.
5. Andrew Zangwill, 2013, Modern Electrodynamics, Cambridge University Press, USA.

NUCLEAR AND PARTICLE PHYSICS

(Course code: 26PPHC33)

Semester III	Core 10	Hours 6	Credits 6
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Course Outcomes: At the end of the course the students must be able to

- CO1** Gain knowledge about the concepts of helicity, parity, angular correlation and internal conversion (K1, K5)
- CO2** Demonstrate knowledge of fundamental aspects of the structure of the nucleus, radioactive decay, nuclear reactions and the interaction of radiation and matter (K2, K3)
- CO3** Use the different nuclear models to explain different nuclear phenomena (K3)
- CO4** Analyze data from nuclear scattering experiments to identify different properties Of the nuclear force (K3, K4)
- CO5** Summarize and identify allowed and forbidden nuclear reactions based on Conservation laws of the elementary particles (K5)
- CO6** Develop the standard model of elementary particles (K6)

UNIT I: PROPERTIES OF NUCLEUS AND NUCLEAR MODELS (18 HOURS)

Properties of Nucleus – General Properties – Size – Charge – Mass – Density – Spin – Magnetic moment – Forces – Nuclear Models – Liquid drop model: Weizsaker's semi empirical mass formula – Bohr Wheeler theory of nuclear fission – Nuclear shell model: Magic numbers - Evidence for magic numbers – Predictions of Shell model – Collective model – Optical model.

UNIT II: NUCLEAR FORCES (18 HOURS)

Introduction – Deuteron – Properties of deuteron – Ground and Excited states – neutron-proton scattering at low energies – proton-proton scattering at low energies – Similarity between nn and pp forces – Meson theory of nuclear forces.

UNIT III: NUCLEAR DECAY (18 HOURS)

Theory of radioactivity – Law of radioactive disintegration – Half-life period – Mean life – Measurement of decay constants – Gamow's theory of alpha decay - The Neutrino hypothesis - Fermi's theory of Beta decay – Violation of parity conservation in Beta decay - Gamma emission: multipole radiation - Internal conversion and nuclear isomerism.

UNIT IV: NUCLEAR REACTIONS AND NEUTRONS (18 HOURS)

Types of Nuclear reactions – Elastic, inelastic, radiative capture, disintegration, direct reactions – Compound nucleus - Reciprocity theorem – Neutron sources – Classification of neutrons – neutron diffusion- neutron current density – leakage rate – Fermi age equation – Four factor formula – Classification of nuclear reactors.

UNIT V: ELEMENTARY PARTICLES (18 HOURS)

Classification of elementary particles – Types of particle interactions – Mesons, Leptons and Hyperons – Particles and antiparticles – Quantum numbers – Conservation laws- CPT –

invariance under charge, parity and time reversal – Quark theory of nuclei – SU2 and SU3 symmetry – baryon octet - meson octet - baryon decuplet – Gell Mann Okuba mass formula – Standard model of particle physics.

BOOKS FOR STUDY:

1. D.C. Tayal–Nuclear Physics–Himalaya Publishing House (2011)
2. K.S. Krane–Introductory Nuclear Physics –John Wiley & Sons (2008)
3. R.Roy and P.Nigam–Nuclear Physics–New Age Publishers (1996)
4. S.B.Patel–Nuclear Physics–An introduction–New Age International Pvt Ltd Publishers (2011)
5. S. Glasstone – Source Book of Atomic Energy – Van Nostrand Reinhold Inc., U.S.- 3rd Revised edition (1968).

BOOKS FOR REFERENCE:

1. L.J. Tassie–The Physics of elementary particles–Prentice Hall Press (1973)
2. H. A. Enge – Introduction to Nuclear Physics – Addison Wesley, Publishing Company. Inc. Reading. New York, (1974).
3. Kaplan–Nuclear Physics–1989 –2nd Ed. –Narosa (2002)
4. Bernard L Cohen–Concepts of Nuclear Physics–McGraw Hill Education (India) Private Limited; 1 edition (2001).

WEB SOURCES:

1. <http://bubl.ac.uk/link/n/nuclearphysics.html>
2. http://www.phys.unsw.edu.au/PHYS3050/pdf/Nuclear_Models.pdfhttp://www.scholarpedia.org/article/Nuclear_Forces
3. <https://www.nuclear-power.net/nuclear-power/nuclear-reactions/>
4. http://labman.phys.utk.edu/phys222core/modules/m12/nuclear_models.html
5. <https://www.ndeed.org/EducationResources/HighSchool/Radiography/radioactivedecay.html>

MICROPROCESSOR 8086

(Course Code: 26PPHC34)

PRACTICALS–V (Any Twelve experiments)

Semester III	Core 11	Hours 4	Credits 2
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List of Experiments:

1. Determine the addition of two 16-bit numbers and verify the result.
2. Perform subtraction of two 16-bit numbers and verify the output.
3. Determine the addition of two multibyte hexadecimal numbers.
4. Perform subtraction of two multibyte hexadecimal numbers.
5. Calculate the sum of elements in an array and verify the result.
6. Perform multiplication of two 16-bit numbers.
7. Determine the division of a 32-bit number by a 16-bit number.
8. Perform addition of two BCD numbers and verify the result.
9. Perform subtraction of two BCD numbers and verify the result.
10. Determine the smallest data element in an array.
11. Determine the largest data element in an array.
12. Sort an array in ascending order.
13. Sort an array in descending order.
14. Perform addition of two matrices.
15. Convert BCD data into binary format.
16. Convert binary data into BCD format.
17. Interface LEDs using the 8255 Programmable Peripheral Interface.
18. Interface a 4x4 keyboard with the microprocessor and verify key detection.

MICROPROCESSOR 8086 AND MICROCONTROLLER
(Course code: 26PPHE31)

Semester III	EC 5	Hours 4	Credits 4
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Course Outcomes: At the end of the course the students must be able to

- CO1** Understand the internal architecture and organization of microprocessor 8086. (K1)
- CO2** Access the various semiconductor memories and memory organisation of 8086. (K2)
- CO3** Discuss the classification of interrupts and the internal architecture of 8259. (K3)
- CO4** Analyse the various peripheral devices and the architecture of 8255. (K4)
- CO5** Gather knowledge about the architecture and instructions of microcontroller 8051. (K5)
- CO6** Develop the knowledge about the basics of serial communication and interrupt registers. (K6)

UNIT I: ARCHITECTURE AND INSTRUCTION SET OF 8086 (12HOURS)

Pins and signals – Architecture – Instruction and data flow – even and odd memory banks - Bus cycles and timing diagram – Addressing modes – Instructions affecting flags – Data transfer instructions – Arithmetic - Logical – String manipulation – Control transfer instructions – CALL and RETURN instructions – Unconditional and conditional jump instructions – Loop instructions - Software instructions – Processor controlled instructions .

UNIT II: MEMORY AND I/O INTERRUPTS (12HOURS)

Semiconductor memory - ROM, PROM, EPROM- Static RAM – Dynamic RAM –NVRAM – Memory organization – I/O structure of a typical microcomputer - Comparison of memory and I/O mapping I/O devices - Interrupts and its need – classification – sources - interrupts of 8086 – implementing interrupt scheme in 8086 – INTR and its expansion – programming interrupt controller – INTEL 8259 – Interfacing 8259 with 8086 – Functional block diagram of 8259 – Processing of interrupts by 8259.

UNIT III: PERIPHERAL DEVICES (12HOURS)

Programmable peripheral devices - parallel data communication interface – parallel data transfer schemes – Programmable peripheral interface 8255 – INTEL8255 – Pins – signals – internal Blockdiagram – Interfacing 8255 with 8086 - DMA data transfer scheme – Serial data communication – Keyboard interface using ports .

UNIT IV : MICROCONTROLLER– 8051 (12HOURS)

Microprocessor and Microcontroller - Overview of 8051 Family – Pin description of 8051 - Registers - Program Counter, ROM space, RAM space, Stack, PSW, SFR registers- Assembly Language Programming - Data Types and Directives - Addressing Modes - Jump Call Instructions - -Arithmetic and Logic Instructions – Bit Instructions - Time delay generations and Calculations

UNIT V : MICROCONTROLLERSFRS AND PROGRAMMING (12HOURS)

Counter / Timer - Counter Programming - Basics of Serial Communication - RS232 Connections and ICs Max 232 - 8051 Serial Communication Registers - Serial Communication Programming - Interrupts - Interrupts Registers - Internal and External Interrupt Programming.

BOOKS FOR STUDY:

1. Nagoorkani, Microprocessor 8086 programming and interfacing–RBA Publications–1st Edition.
2. Muhammed Ali Mazidi, The 8051 Microcontroller and Embedded System, Pearson Publications, 13th Edition

BOOKS FOR REFERENCE:

1. A.P.Godse and D.A.Godse–Microprocessors and microcontrollers–Technical Publications.
2. Barry Brey, Intel Microprocessor 8086/8088, 80186, 80286, 80386, 80486, Prentice Hall India((1996)

INTRODUCTION TO PYTHON PROGRAMMING
(Course code: 26PPHE31)

Semester III	EC 5	Hours 4	Credits 4
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Course Outcomes: At the end of the course the students must be able to

- CO1** To understand the fundamental concepts of Python programming and its syntax (K1)
- CO2** Apply operators, control structures, and functions in developing Python programs (K2)
- CO3** Utilize strings and collections including lists, tuples, and dictionaries for data manipulation (K3)
- CO4** Implement file handling operations and exception handling techniques for robust programming (K4)
- CO5** Design applications incorporating modules and Object-Oriented Programming principles (K5)
- CO6** Solve practical problems utilizing computational skills and Python libraries (K6)

UNIT I: INTRODUCTION TO PYTHON PROGRAMMING (12 Hours)

Introduction to Python – Features of Python – Installing Python – Python IDE and execution modes – Tokens, keywords and identifiers – Variables and data types – Input and output statements – Type conversion – Operators in Python – Expressions and operator precedence – Writing and executing simple Python programs.

UNIT II: CONTROL STRUCTURES AND FUNCTIONS (12 Hours)

Conditional statements – if, if-else, nested if and elif statements – Looping statements – while loop and for loop – break, continue and pass statements – Functions – Function definition and function call – Arguments and return values – Scope of variables – Recursive functions – Lambda functions.

UNIT III: STRINGS AND COLLECTIONS (12 Hours)

Strings – String operations and built-in functions – List and list methods – Tuple and tuple operations – Dictionary and dictionary methods – Set and set operations – Nested collections – List comprehension – Basic problem solving using collections.

UNIT IV: FILE HANDLING AND EXCEPTION HANDLING (12 Hours)

Files and file operations – Opening, reading, writing and appending files – File modes – Working with text files – Exception handling – try, except, finally blocks – User-defined exceptions – Debugging techniques – Introduction to Python standard libraries.

UNIT V: OBJECT ORIENTED PROGRAMMING AND APPLICATIONS (12 Hours)

Introduction to Object Oriented Programming – Classes and objects – Constructors – Instance and class variables – Inheritance – Polymorphism – Modules and packages – Introduction to NumPy and Matplotlib – Simple applications in scientific and data processing using Python.

BOOKS FOR STUDY:

1. Python Programming: Using Problem Solving Approach, Reema Thareja, 1st ed., Oxford University Press, 2019.
2. Core Python Programming, Dr. R. Nageswara Rao, 2nd ed., Dreamtech Press, 2018.

BOOKS FOR REFERENCE:

1. Python Crash Course, Eric Matthes, 3rd ed., No Starch Press, 2022.
2. *Learning Python*, Mark Lutz, 5th ed., O'Reilly Media, 2013.
3. Think Python, Allen B. Downey, 3rd ed., O'Reilly Media, 2024.
4. Introduction to Computation and Programming Using Python, John V. Guttag, 3rd ed., MIT Press, 2021.

WEB SOURCES

1. <https://www.python.org/doc/>
2. <https://www.w3schools.com/python/>
3. <https://www.geeksforgeeks.org/python-programming-language/>
4. <https://nptel.ac.in/courses/115104135>
1. <https://www.tutorialspoint.com/python/index.htm>

MICROCONTROLLER 8051

(Course Code: 26PPHS31)
PRACTICALS – VI (Any Twelve experiments)

Semester III	SEC 2	Hours 4	Credits 2
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List of Experiments

1. Perform addition of two 6-bit numbers and verify the result.
2. Determine subtraction of two 8-bit numbers and validate the output.
3. Perform multiplication of two 8-bit numbers.
4. Determine the one's and two's complement of an 8-bit number.
5. Set specific bits in an 8-bit number and verify the result.
6. Mask selected bits in an 8-bit number and validate the output.
7. Perform basic arithmetic operations (addition, subtraction, multiplication, division) using assembly instructions.
8. Calculate the sum of elements in an array.
9. Perform addition of multiprecision (multi-byte) numbers.
10. Determine division of two 8-bit numbers.
11. Convert ASCII input into decimal format.
12. Disassemble a word into its constituent bytes.
13. Convert hexadecimal numbers into decimal format.
14. Convert decimal numbers into hexadecimal format.
15. Determine the largest element in an array.
16. Sort an array in ascending order.
17. Implement stack operations and subroutine calls.
18. Create delay loops using assembly instructions and verify timing.

SPECTROSCOPIC TECHNIQUES
(Course code: 26PPHC41)

Semester IV	Core 12	Hours 6	Credits 5
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Course Outcomes: At the end of the course the students must be able to

- CO1** Remember the basics on characterization of Electromagnetic radiation (K1)
- CO2** Understand the applications of microwave, IR, Raman spectroscopy (K2)
- CO3** Apply the spectroscopic techniques to analyze different mechanism (K3)
- CO4** Analyze and interpret the FTIR, Raman and Resonance spectrum (K4)
- CO5** Evaluate linear, vibrational and rotational motion of the molecules (K5)
- CO6** Learn different spectroscopic techniques to analyse molecular structure (K6)

UNITI: MICROWAVE SPECTROSCOPY (18HOURS)

Rotational spectra of diatomic molecules – Rigid Rotor (Diatomic Molecules) - reduced mass – rotational constant - Effect of isotopic substitution - Non rigid rotator – centrifugal distortion constant - Intensity of Spectral Lines - Polyatomic molecules – linear – symmetric asymmetric top molecules - Microwave Spectrometer - Instrumentation techniques – block diagram - Stark effect.

UNITII: INFRARED SPECTROSCOPY (18HOURS)

Vibrational energy of the diatomic molecule – vibrating diatomic molecule - Diatomic Vibrating Rotator - vibrations of polyatomic molecules - Fundamental modes of vibration of H₂O and CO₂ - Introduction to application of vibrational spectra - IR Spectrophotometer Instrumentation (Double Beam Spectrometer) – Fourier Transform Infrared Spectroscopy

UNITIII: RAMAN SPECTROSCOPY (18HOURS)

Theory of Raman Scattering - Classical theory - Quantum theory of Raman scattering - rotational Raman spectra of linear molecule - symmetric top molecule – Stokes and anti-stokes line - Mutual exclusion principle - Raman Spectrometer - Instrumentation technique and block diagram - FT Raman spectroscopy - SERS

UNITIV: ELECTRONIC AND MOSSBAUER SPECTROSCOPY (18HOURS)

Vibrational coarse structure-Vibrational analysis of band systems - Frank Condon principle - Rotational fine structure of vibration spectra - The Fortrat parabola - Dissociation - Pre Dissociation - Electronic angular momentum in diatomic molecules - Photo Electron spectroscopy - Recoilless Emission and Absorption-Experimental Techniques - Isomer shift - Quadrupole interaction - Application

UNITV: RESONANCE SPECTROSCOPY (18HOURS)

NMR – Magnetic properties of nuclei - Resonance conditions - NMR instrumentation - Relaxation process - Bloch Equations - Chemical shift - NMR Spectra of solids - Magnetic angle spinning NMR - Nuclear Quadrupole effects - NMR imaging

ESR - Principle of ESR - ESR Spectrometer - Fine and Hyperfine spectrometer - Double resonance in ESR.

BOOKS FOR STUDY:

1. C N Banwell and E M McCash, 1994, Fundamentals of Molecular Spectroscopy, 4th Edition, Tata McGraw–Hill, New Delhi.
2. G Aruldas, 1994, Molecular Structure and Molecular Spectroscopy, Prentice–Hall of India, New Delhi.
3. D.N.Satyanarayana, 2001, *Vibrational Spectroscopy and Applications*, New Age International Publication.
4. B.K.Sharma, 2015, *Spectroscopy*, Goel Publishing House Meerut.
5. Kalsi.P.S, 2016, Spectroscopy of Organic Compounds (7th New Age International Publishers.

Edition),

BOOKS FOR REFERENCE:

1. J LMcHale, 2008, Molecular Spectroscopy, Pearson Education India, New Delhi.
2. JMHollas, 2002, Basic Atomic and Molecular Spectroscopy, Royal Society of Chemistry, RSC, Cambridge.
3. B. P. Straughan and S. Walker, 1976, Spectroscopy Vol. I, Chapman and Hall, New York.
4. K.Chandra, 1989, Introductory Quantum Chemistry, Tata McGraw Hill, New Delhi.
5. Demtroder. W, Laser Spectroscopy: Basic concepts and Instrumentation, SpringerLink.

NUMERICAL METHODS AND PROGRAMMING WITH C++

(Course Code: 26PPHC42)

Semester IV	Core 13	Hours 6	Credits 5
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Course Outcomes: At the end of the course the students must be able to

CO1: Understand the basic concept involved in root finding procedure such as Newton Raphson and Bisection methods, their limitations (K1)

CO2: Relate simultaneous linear equations and their matrix representation (K2)

CO3: Understand the interpolation techniques used in various realms of physics and know to apply in some simple problems (K3)

CO4: Analyze the Newton forward and backward interpolation (K4)

CO5: Assess the trapezoidal and Simpson's method of numerical integration (K5)

CO6: Understand the basics of C++ programming and conditional statements (K6)

UNIT I: SOLUTIONS OF EQUATIONS (18 HOURS)

Roots of an equation - Bisection method- Regula Falsi method-Secant method- Newton-Raphson method-Convergence of Regula Falsi method- Order of convergence of Newton Raphson Method .

UNIT II: SIMULTANEOUS LINEAR SYSTEM OF EQUATIONS (18 HOURS)

Solution of simultaneous equations by Gaussian elimination method – Inverse of a Matrix by Gaussian elimination method — Gauss Jordan method –Gauss Seidal method - Eigenvalues: Power method- Gauss Jacobi method to find the dominant Eigen value

UNIT III: INTERPOLATION AND CURVEFITTING (18 HOURS)

Interpolation with equally spaced points-Newton forward and backward interpolation - Interpolation with unevenly spaced points –Lagrange interpolation–Curve fitting–Method of least squares–Fitting a polynomial- straight line, fitting a parabola, fitting $y = ax^n$, $y = ae^{bx}$ type curves

UNIT IV : NUMERICAL DIFFERENTIATION AND INTEGRATION (18 HOURS)

Numerical differentiation–Derivatives using Newton's forward and backward difference formula- Numerical integration–Trapezoidal rule–Simpon's 1/3 rule, Simpson's 3/8 rule, - Error estimates in trapezoidal and Simpson's rule– Basic Euler method – Improved and modified Euler method – Runge Kutta fourth order method –solution of ordinary differential equations by RK fourth order Method.

UNIT V: PROGRAMMING WITH C++ (18 HOURS)

Program structure and header files – Basic data types – operators – Control Structure: decision making and looping statements. Arrays, Structures, User defined functions-Application programs – Roots of equations by Newton Raphson Method and Bisection method – Solving simultaneous equations using Gauss –Jordan Method, Gauss Seidal and Gauss Elimination methods- Linear curve fitting using least square method and exponential curve-Lagrangian interpolation – Numerical integration using Euler's method, Simpson 1/3 rule and RK method.

BOOKS FOR STUDY:

- 1.S.S.Sastry, Introductory Methods of Numerical Analysis, PHI, NewDelhi.
- 2.Numerical Methods, Babu Ram, Pearson Education, New Delhi.
- 3.Numerical Methods, N.V. Vedomurthy, S.N. Iyengar, Vikas Publishing House, New Delhi.
- 4.Programming in ANSI C++, E. Balagurusamy, Tata McGraw- Hill, India, 4th Edition.

BOOKS FOR REFERENCE

- 1.S.D.Conte and C.deBoor,1981,ElementaryNumericalanalysis-An algorithmic approach, 3rd Edition, McGrawHill.
2. B. F. Gerald, and P.O.Wheatley,1994,Applied Numericalanalysis, 5th Edition, Addison-Wesley, MA.
3. M. K .Jain, S. R. Iyengar and R. K. Jain, 1995, Numerical Methods for Scientific and Engineering Computation, 3rdEdition, NewAgeIntl., NewDelhi.

WEB SOURCES

1. <https://www.scribd.com/doc/202122350/Computer-Oriented-Numerical-Methods-by-V-RajaRaman>
2. [https://www.scirp.org/\(S\(lz5mqp453edsnp55rrgjt55\)\)/reference/referencespapers.aspx?referenceid=1682874](https://www.scirp.org/(S(lz5mqp453edsnp55rrgjt55))/reference/referencespapers.aspx?referenceid=1682874)
3. <https://nptel.ac.in/course/122106033/>
4. <https://nptel.ac.in/course/103106074/>
5. https://onlinecourses.nptel.ac.in/noc20_ma33/preview

Skill Based Activities

Developing Programming skill to analyze the basic concepts of physics and design circuits

- Charging and discharging of a condenser by Euler's Method
- Radioactive Decay by Runge Kutta fourth order method
- Currents in Wheatstone's bridge by Gauss elimination method
- Cauchy's constant by least square method
- Evaluation of integral by Simpson's method
- Newton's Law of cooling by Numerical differentiation

PHYSICS OF NANOSCIENCE AND TECHNOLOGY
(Course Code: 26PPHE41)

Semester IV	EC 6	Hours 4	Credits 3
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Course Outcomes: At the end of the course the students must be able to

- CO1** Recall historical development, classification, and synthesis methods of nanomaterials (K1)
- CO2** Grasp properties of special nanomaterials: carbon fullerenes, nanotubes, etc (K2)
- CO3** Apply knowledge of physical, mechanical, optical, and electrical properties to nano-scale analysis (K3)
- CO4** Analyze synthesis techniques: vapor deposition, sol-gel, ballmilling, lithography, etc. (K4)
- CO5** Evaluate structural and chemical characterization techniques: XRD, STM, TEM, spectroscopy (K5)
- CO6** Create applications in electronics, colorants, DNA chips, drug delivery, etc. (K6)

UNITI: INTRODUCTION (12HOURS)

Introduction- History of nanotechnology -Bottom up and Top down approach - Classification of nanomaterials: Definition of -Zero, one and two dimension nano structures-. Surface energy - Chemical potential as a function of surface curvature - Electrostatic stabilization - DLVO Theory - Steric stabilization.

UNITII:SPECIALNANOMATERIALS (12HOURS)

Carbon Fullerenes and Nanotubes: Carbon fullerenes, Fullerene derived crystals, Carbon nanotubes. Micro and Mesoporous Materials: Ordered mesoporous structures, Random mesoporous structures, crystalline microporous materials. Core-shell structures: Metal-oxide structures, Metal- polymer structures–Nanocomposites.

UNITIII:PROPERTIES (12HOURS)

Physical properties of nanomaterials: Melting points, Specific heat capacity and lattice constants - Mechanical properties - Optical properties - Surface Plasmon Resonance - Quantum size effects- Electrical property: Surface scattering- Change of electronic structure - Variation of magnetism with size-Super para magnetism.

UNITIV: SYNTHESIS (12HOURS)

Synthesis of nano materials: Physical vapour deposition - Chemical vapour deposition- plasma arching- Chemical methods Sol gel - Ball milling technique - Reverse micellar technique - Electro deposition. Synthesis of Semiconductors: Nanostructures fabrication by physical techniques - lithography - electron beam lithography - Photo lithography - X-Ray lithography

UNITV:CHARACTERIZATION AND APPLICATIONS (12HOURS)

Structural Characterization: X-Ray diffraction- Scanning electron microscopy- Scanning probe Microscopy-Transmission Electron Microscopy-Chemical Characterization: Optical spectroscopy-UV Vis Spectroscopy- FTIR spectroscopy -Raman Spectroscopy
Applications: Molecular electronics and Nano electronics:-Nano mechanics - Quantum well devices- Nano medicines- Nano Photonics.

BOOKS FOR STUDY:

1. Nano structures and Nanomaterials, Synthesis, Properties and Application Guazhong Cao, Imperial College press.
2. Nanotechnology, Wilson M, K Kannangara, G. Smilt, M. Simmons and B. Boguse-Overseas Press, 2005
3. Nanoscale Materialsin Chemistry, Kenneth F. Klablunde, John wiley and sons, Inc., 2001.
4. TheEssentials,Pradeep T,Nano:TataMCGraw-Hillpublishingcompanylimited,2007.

BOOKS FOR REFERENCE:

1. Nano biotechnology: Concepts, Applications and Perspectives, Christ of M.Niemeyer, Chad A.4.Mirkin, 2004,
2. Nanomedicine, FreitasRA, Landes.,TX publication,1996.
3. NanoMaterials,Viswanathan B, Narosa publishing house, 2010.

ATMOSPHERIC PHYSICS
(Course Code: 26PPHE41)

Semester IV	EC 6	Hours 4	Credits 3
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Course Outcomes: At the end of the course the students must be able to

- CO1** To impart knowledge on the physical universe and its evolution (K1)
- CO2** To make the student to understand fundamental principles and techniques of astronomy and astrophysics (K2)
- CO3** To make the student to study electromagnetic radiation from stars, atomic spectra and classification of stars (K3)
- CO4** To provide information about the properties and the evolution of stars (K4)
- CO5** To render information about astronomical instrumentation (K5)
- CO6** To have a deep knowledge about cosmic radiations and neutrinos (K6)

UNIT I: PHYSICAL & DYNAMIC METEOROLOGY (12 HOURS)

Physical Meteorology: Structure of Earth's Atmosphere and Composition- Law of Thermodynamics of the Atmosphere- Adiabatic Process-Potential Temperature-Clausius-Clapyeron Equation-Laws of Black Body Radiation-Solar and Terrestrial Radiation-Albedo-Green House Effect-Heat Balance of Earth Atmosphere System.

UNIT II: DYNAMIC METEOROLOGY (12 HOURS)

Fundamental Forces-Structure of Static Atmosphere-Momentum, Continuity and Energy Equations-Thermodynamics of the Dry Atmosphere-Elementary Applications of the Basic Equations-Circulation Theorem-Vorticity-Potential Vorticity and Potential Vorticity Equations.

UNIT III: CLIMATE & MONSOON DYNAMICS (12 HOURS)

Climate Classification-Polar, Artic, Antarctic, Temperate & Tropical Climates Wind, Temperature & Pressure Distribution over India in the Lower, Middle and Upper Atmosphere during Pre- Post- and Mid-Monsoon Season-Dynamics of Monsoon Depression and Easterly Waves-Intra Seasonal and Interannual Variability of Monsoon-Quasi-Bi Weekly and 30-60 Day Oscillations-Walker Circulation, Southern Oscillations & El Nino

UNIT IV: ATMOSPHERIC POLLUTION (12 HOURS)

Role of Meteorology in Atmospheric Pollution-Atmospheric Boundary Layer-Air Stability-Local Wind Structure-Ekman Spiral-Turbulence & Boundary Layer Scaling-Residence Time and Reaction Rates of Pollutants-Sulphur Compounds-Carbon Compounds-Organic compounds-Aerosols- Toxic Gases and Radio Active Particles-Trace Gases

UNIT V: RADAR METEOROLOGY (12 HOURS)

Basic Meteorology-Radar Principles and Technology-Radar Signal Processing & Display-Weather Radar- Observation of Precipitating Systems-Estimation of Precipitation-Radar observation of Tropical Storms & Cyclones-Use of Weather Radar in Aviation-Clear Air Radars-Observation of a Clear Air Phenomena

BOOKS FOR STUDY:

1. Atmospheric Science: An Introductory Survey, John M. Wallace and Peter V. Hobbs, Academic Press, 2nd Edition, 2006.
2. Atmospheric Physics, John Houghton, Oxford University Press, 1st Edition, 2002.
3. Introduction to Atmospheric Physics, David G. Andrews, Cambridge University Press, 1st Edition, 2010.

BOOKS FOR REFERENCE:

1. Dynamic Meteorology- J.R. Holton- Academic Press- NY
2. The Physics of Monsoons - R.N. Keshvamurthy & M. Shankar Rao-Allied Publishers
3. Principles of Air Pollution Meteorology - Tom Lyons & Prillscott - CBS Publishers & Distributors

NUMERICAL METHODS USING C
(Course Code: 26PPHS41)
PRACTICALS–VII (Any Eight experiments)

Semester IV	SEC 3	Hours 4	Credits 2
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List of Experiments:

1. Determine the value of a function at a given point using Lagrange's interpolation formula.
2. Apply Newton's forward interpolation method to estimate values of a function.
3. Use Newton's backward interpolation formula to determine function values near the end of a data set.
4. Perform least-squares curve fitting to approximate data with a suitable function.
5. Determine the numerical integration of a function using the trapezoidal rule.
6. Verify numerical integration using Simpson's 1/3 rule.
7. Determine the root of a polynomial using the bisection method.
8. Apply Newton–Raphson method to find polynomial roots.
9. Solve simultaneous linear equations using Gauss elimination method.
10. Solve simultaneous linear equations using Gauss Jordan method.
11. Determine the solution of an ordinary differential equation using Euler's method.
12. Apply the Runge–Kutta fourth order method to solve ordinary differential equations.

INTRODUCTION TO ARTIFICIAL INTELLIGENCE
(Course Code: 23PPHVA1)

I st YEAR	VAC 1	Hours 3	Credits 3
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Course Outcomes: At the end of the course the students must be able to

CO1 Understand the fundamentals and history of Artificial Intelligence. (K1)

CO2 Explain the concepts of machine learning, neural networks and data processing. (K2)

CO3 Apply basic AI tools and programming techniques for simple applications. (K3)

CO4 Analyze AI algorithms and their applications in real-world problems. (K4)

CO5 Evaluate ethical issues, challenges and future trends in Artificial Intelligence. (K5)

CO6 Create simple AI-based applications using Python and PyTorch. (K6)

UNIT I: FUNDAMENTALS OF ARTIFICIAL INTELLIGENCE (6 HOURS)

Introduction to Artificial Intelligence – History and evolution of AI – Types of AI – Narrow AI and General AI – Intelligent agents – Applications of AI – AI in healthcare, education, robotics and industry – Advantages and limitations of AI.

UNIT II: PYTHON FOR AI (6 HOURS)

Introduction to Python – Variables and data types – Operators and expressions – Conditional and looping statements – Functions and modules – Lists, tuples and dictionaries – Introduction to NumPy and Pandas – Jupyter Notebook and Anaconda installation.

UNIT III: MACHINE LEARNING BASICS (6 HOURS)

Introduction to Machine Learning – Supervised and unsupervised learning – Classification and regression – Training and testing datasets – Overfitting and underfitting – Introduction to neural networks – Basics of deep learning – Applications of machine learning.

UNIT IV: AI TOOLS AND APPLICATIONS (6 HOURS)

Introduction to AI frameworks – Overview of PyTorch and Scikit-learn
– Natural Language Processing – Computer Vision – Speech recognition – Chatbots and virtual assistants – Recommendation systems – Introduction to generative AI.

UNIT V: ETHICS, FUTURE TRENDS AND MINI PROJECTS (6 HOURS)

Ethical issues in AI – Bias and fairness – Privacy and security – AI regulations and challenges – Future of AI – AI and employment – AI in autonomous systems – Simple AI mini projects and demonstrations using Python and PyTorch.

BOOKS FOR STUDY:

1. Artificial Intelligence: A Modern Approach, Stuart Russell and Peter Norvig, 4th ed., Pearson Education, 2020.
2. Python Machine Learning, Sebastian Raschka and Vahid Mirjalili, 3rd ed., Packt Publishing, 2019.
3. Deep Learning with PyTorch, Eli Stevens, Luca Antiga, and Thomas Viehmann, 1st ed., Manning Publications, 2020.

BOOKS FOR REFERENCE

1. *Deep Learning*, Ian Goodfellow, YoshuaBengio, and Aaron Courville, 1st ed., MIT Press, 2016.
2. *Artificial Intelligence for Humans*, Jeff Heaton, 1st ed., Heaton Research Publications, 2013.
3. *Machine Learning*, Tom M. Mitchell, 1st ed., McGraw-Hill Education, 1997.

WEB RESOURCES

<https://pytorch.org/docs/stable/index.html> PyTorch Official Documentation

<https://www.tensorflow.org/> TensorFlow Documentation

<https://scikit-learn.org/> Scikit-learn Documentation

<https://www.kaggle.com/learn> Kaggle Learn AI Courses

<https://nptel.ac.in/courses/106102220> NPTEL Artificial Intelligence Courses

<https://colab.research.google.com/> Google Colab

QUANTUM COMPUTING
(Course Code: 23PPHVA2)

I st YEAR	VAC 2	Hours 3	Credits 3
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Course Outcomes: At the end of the course the students must be able to

- CO1** Recall the fundamental concepts of quantum computing and qubits. (K1)
- CO2** Understand the basics of Python programming and Qiskit framework. (K2)
- CO3** Apply quantum gates and create simple quantum circuits using Qiskit. (K3)
- CO4** Analyze basic quantum algorithms and compare them with classical approaches. (K4)
- CO5** Evaluate quantum communication concepts such as teleportation and Deutsch algorithm. (K5)
- CO6** Create simple quantum programs and circuits using Python and Qiskit. (K6)

UNIT I: INTRODUCTION TO QUANTUM COMPUTING (6 HOURS)

Classical computers and quantum computers – Probability and complex numbers – Matrices and matrix operations – Introduction to qubits – Superposition and interference – Entanglement – Bra-ket notation – Multi-qubit systems.

UNIT II: PYTHON FOR QUANTUM COMPUTING (6 HOURS)

Introduction to Python – Variables and data types – Lists, tuples, dictionaries and sets – Conditional and looping statements – Functions and modules – Using Python libraries – Introduction to Anaconda and Jupyter Notebook.

UNIT III: INTRODUCTION TO QISKIT (6 HOURS)

Introduction to Qiskit – IBM Quantum platform – Classical and quantum gates – Quantum circuits – Entanglement using Qiskit – Creating and executing simple quantum circuits – Introduction to Toffoli gate.

UNIT IV: QUANTUM COMMUNICATION AND ALGORITHMS (6 HOURS)

Introduction to Bloch sphere – Quantum teleportation – Deutsch algorithm – Bernstein-Vazirani algorithm – Introduction to quantum error correction – Applications of quantum communication.

UNIT V: GROVER'S AND SHOR'S ALGORITHMS (6 HOURS)

Introduction to Grover's search algorithm – Classical versus quantum search – Grover's algorithm using Qiskit – Introduction to Shor's algorithm – Quantum Fourier Transform – Overview of quantum hardware and applications.

BOOKS FOR STUDY:

1. Quantum Computing for Computer Scientists, Mirco A. Mannucci and Noson S. Yanofsky, Cambridge University Press, 2008.
2. Programming Quantum Computers: Essential Algorithms and Code Samples, Eric R. Johnston, NicHarrigan, Mercedes Gimeno-Segovia, O'Reilly Media, 2019
3. Python Crash Course, Eric Matthes, No Starch Press, 2016.
4. Mastering Quantum Computing with IBM QX, Christine Corbett Moran, Packt Publishing, 2019.
5. Quantum Computing: An Applied Approach, Jack D.Hidary, Springer Nature, 2019.
6. Quantum Computing since Democritus, Scott Aaronson, Cambridge University Press, 2013.

BOOKS FOR REFERENCE:

1. Quantum Computation and Quantum Information, M. A. Nielsen, I. Chuang, Cambridge University Press, 2010.
2. Quantum Computing: From Linear Algebra to Physical Realizations, Mikio Nakahara, CRC Press,

2008.

3. Quantum Computer Science: An Introduction, N. David Mermin, Cambridge University Press, 2007.
4. Classical and Quantum Computation, A. Shen, A. Kitaev, and M. Vyalyi, American Mathematical Society, 2002.
5. An introduction to quantum computing, P. Kaye, R. Laflamme, M. Mosca, Oxford University Press, 2006.
6. Quantum Computing as a High School Module, A Perry, arXiv, 2019.

WEB RESOURCES:

1. <https://indico.cern.ch/event/970909/>
2. <https://quantum.ibm.com>
3. <https://people.eecs.berkeley.edu/~vazirani/f04quantum/quantum.html>
4. <https://www.cs.tufts.edu/comp/150QCS/>
5. <https://www.khanacademy.org/math/linear-algebra>

ENERGY PHYSICS
(CourseCode:26PPHEC1)

II nd YEAR	ECC 1	Hours 3	Credits 3
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Course Outcomes: At the end of the course the students must be able to

- CO1** To learn about various renewable energy sources (K1).
- CO2** To know the ways of effectively utilizing the oceanic energy (K2)
- CO3** To study the method of harnessing windenergy and its advantages (K3)
- CO4** To learn the techniques useful for the conversion of biomass into energy (K4)
- CO5** To know about utilization of solar energy (K5)
- CO6** To understand the various sources of solar energy (K6)

UNIT I: INTRODUCTION TO ENERGY SOURCES

Conventional and non-conventional energy sources and their availability – prospects of Renewable energy sources – Energy from other sources – chemical energy – Nuclear energy

UNIT II: ENERGY FROM THE OCEANS

Energy from tidal Energy – Basic principle of tidal power – utilization tidal energy – Application of Tidal Energy

UNIT III: WIND ENERGY SOURCES

Basic principles of wind energy conversion – power in the wind – Wind energy conversion – Advantages and disadvantages of wind energy conversion

UNIT IV: ENERGY FROM BIOMASS

Biomass conversion Technologies – wet and dry process – Biogas Generation: Introduction – Aerobic and anaerobic digestion – Advantages of anaerobic digestion.

UNIT V: SOLAR ENERGY SOURCES

Solar cells: Solar cells for direct conversion of solar energy to electric powers – solar water Heater – solar distillation – solar cooking – solar green house – Solar pond and its applications.

BOOKS FOR STUDY

1. G.D. Rai, 1996, Non – conventional sources of, 4th edition, Khanna publishers, New Delhi.
2. Principles of Energy Conversion, Archie W. Culp and Charles C. Williams, McGraw-Hill Education, 1st Edition, 1982.

BOOKS FOR REFERENCE

1. Renewable energy resources, John Twidell and Tony weir, Taylor and Francis

group, London and New York.

2. Introduction to Non-Conventional Energy Resources – Raja et al., Sci. Tech Publications.

CHARACTERISATION OF MATERIALS
(Course Code: 23PPHEC2)

II nd YEAR	ECC 2	Hours 3	Credits 3
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Course Outcomes: At the end of the course the students must be able to

CO1 Introduce the students to the basics of x-ray diffraction techniques and some important spectroscopic techniques. (K1)

CO2 Make the students understand some important electrical and optical characterization techniques for semiconducting materials. (K2)

CO3 Understand the methods of various spectroscopic techniques (K3)

CO4 Make the students understand the theory of image formation in an optical microscope and to introduce other specialized microscopic techniques. (K4)

CO5 Make the students learn and understand the principle of working of electron microscopes and scanning probe microscopes. (K5)

CO6 Make the students learn some important thermal analysis techniques namely TGA, DTA, DSC and TMA. (K6)

UNIT I: X-RAY AND SPECTROSCOPIC METHODS

Principles and instrumentation for UV-Vis-IR, FTIR spectroscopy, Raman spectroscopy, XPS, Powder diffraction - Powder diffractometer -interpretation of diffraction patterns - indexing - phase identification - residual stress analysis – Particle size

UNIT II: ELECTRICAL METHODS AND OPTICAL CHARACTERISATION

Two probe and four probe methods- van der Pauw method – Hall probe and measurement – C- V characteristics –Photoluminescence – light – matter interaction – instrumentation

UNIT III: ELECTRON MICROSCOPY AND SCANNING PROBE MICROSCOPY

SEM, EDAX, TEM: working principle and Instrumentation – sample preparation –Data collection, processing and analysis- Atomic force microscopy (AFM)

UNIT IV: MICROSCOPIC METHODS

Optical Microscopy: optical microscopy techniques – Bright field optical microscopy – Dark field optical microscopy – Dispersion staining microscopy - fluorescence microscopy

UNIT V: THERMAL ANALYSIS

Introduction – thermo gravimetric analysis (TGA) – instrumentation – determination of weight loss and decomposition products – differential thermal analysis (DTA)

BOOKS FOR STUDY:

1. R. A. Stradling and P. C. Klipstain. Growth and Characterization of semiconductors. Adam Hilger, Bristol, 1990.
2. J. A. Belk. Electron microscopy and microanalysis of crystalline materials. Applied Science Publishers, London, 1979.
3. Lawrence E. Murr. Electron and Ion microscopy and Microanalysis principles and Applications. Marcel Dekker Inc., New York, 1991
4. D. Kealey and P. J. Haines. Analytical Chemistry. Viva Books Private Limited, New Delhi, 2002.
5. Li, Lin, Ashok Kumar Materials Characterization Techniques Sam Zhang; CRC Press, (2008).

BOOKS FOR REFERENCE:

1. Cullity, B.D., and Stock, R.S., Elements of X-Ray Diffraction”, Prentice-Hall, (2001).
2. Murphy, Douglas B, Fundamentals of Light Microscopy and Electronic Imaging, Wiley-Liss, Inc. USA, (2001).
3. Tyagi, A.K., Roy, Mainak, Kulshreshtha, S.K., and Banerjee, S., Advanced Techniques for Materials Characterization, Materials Science Foundations (monograph series), Volumes 49 – 51, (2009). Volumes 49 – 51, (2009).
4. Wendlandt, W.W., Thermal Analysis, John Wiley & Sons, (1986).

INTRODUCTION TO UNMANNED AIRCRAFT SYSTEMS

(Course Code: 26PPEC3)

II nd YEAR	ECC 3	Hours 3	Credits 3
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Course Outcomes: At the end of the course the students must be able to

CO1 To comprehend the fundamental principles and classifications of Unmanned Aircraft Systems (K1)

CO2 To acquire specialized knowledge concerning the structural components and operation of unmanned aerial vehicles (K2)

CO3 To understand the navigation, communication, and control systems utilized within UAS (K3)

CO4 To gain insights into the integration of sensors and payload systems in unmanned aircraft (K4)

CO5 To interpret the diverse applications, safety protocols, and regulatory frameworks governing UAS (K5)

CO6 To analyze contemporary technological advancements and emerging trends in unmanned aircraft (K6)

UNIT I: FUNDAMENTALS OF UNMANNED AIRCRAFT SYSTEMS (6 Hours)

Introduction to UAS – Historical evolution of drones – Classification: Fixed-wing, rotary-wing, and hybrid UAVs – Merits and inherent limitations – Aerodynamic principles: Lift, drag, thrust, and weight – Overview of system architecture.

UNIT II: UAV COMPONENTS AND PROPULSION SYSTEMS (6 Hours)

Airframe design – Advanced materials – Electric propulsion: Motors, ESCs, and propellers – Battery technologies and power distribution management – Flight control units – Ground control stations – Strategies for payload integration.

UNIT III: NAVIGATION, GUIDANCE AND COMMUNICATION SYSTEMS (6 Hours)

Dynamics of flight and stability – GPS and GNSS technologies – Inertial Measurement Units (IMU) – Autopilot architectures – Telemetry protocols – Radio frequency communication and data links – Mission planning and autonomous waypoint navigation.

UNIT IV: SENSORS, CONTROL SYSTEMS AND PAYLOADS (6 Hours)

Atmospheric and motion sensors: Gyroscope, accelerometer, and barometer – Imaging systems: Optical, thermal, and LiDAR – PID control theory – Obstacle detection and collision avoidance – Payload specialization in defense and precision agriculture.

UNIT V: APPLICATIONS, SAFETY AND REGULATIONS (6 Hours)

Multi-disciplinary applications: Defense, logistics, and disaster management – Safety procedures and risk assessment – National and international airspace regulations – Ethical considerations – Overview of DGCA guidelines – Future paradigms in AI-enabled autonomous UAVs.

Textbooks

1. Introduction to Unmanned Aircraft Systems, by R. Kurt Barnhart, Douglas M. Marshall, and

- Eric Shappee, 3rd Edition, CRC Press, 2021
2. Design of Unmanned Aerial Systems, by Mohammad H. Sadraey, 1st Edition, Wiley, 2020
3. Introduction to UAV Systems, by Paul GerinFahlstrom and Thomas James Gleason, 4th Edition, Wiley, 2012
4. Small Unmanned Aircraft: Theory and Practice, by Randal W. Beard and Timothy W. McLain, 1st Edition, Princeton University Press, 2012
5. Unmanned Aircraft Systems: UAVS Design, Development and Deployment, by Reg Austin, 1st Edition, Wiley, 2010
6. Introduction to Modern Navigation Systems, by Esmat Bekir, 1st Edition, World Scientific Publishing Company, 2007
7. Remote Pilot – Small Unmanned Aircraft Systems Study Guide, by Federal Aviation Administration (FAA), 1st Edition, U.S. Department of Transportation, 2016

Books for Reference

1. Small Unmanned Fixed-wing Aircraft Design: A Practical Approach, by Andrew J. Keane, AndrásSóbester, and James P. Scanlan, 1st Edition, Wiley, 2017
2. Fundamentals of Aerospace Engineering, by Manuel Soler, 2nd Edition, CreateSpace Independent Publishing Platform, 2017
3. Aircraft Design: A Conceptual Approach, by Daniel P. Raymer, 6th Edition, American Institute of Aeronautics and Astronautics, 2018 [1, 2]
4. Drone Technology in Architecture, Engineering and Construction, by Daniel Tal and Jon Altschuld, 1st Edition, Wiley, 2021
5. Pilot's Handbook of Aeronautical Knowledge, by Federal Aviation Administration (FAA), 1st Edition, U.S. Department of Transportation, 2023

WEB SOURCES

- <https://www.faa.gov/uas> – Federal Aviation Administration – UAS Information
- <https://digitalsky.dgca.gov.in/> – DGCA India Drone Regulations
- <https://www.nasa.gov/aeroresearch/programs/aosp/uas/> – NASA Unmanned Aircraft Systems Research
- <https://nptel.ac.in/courses/101101079> – NPTEL Aerospace Engineering Courses
- <https://ocw.mit.edu/courses/aeronautics-and-astronautics/> – MIT Open Course Ware – Aeronautics and Astronauti

LASER PHYSICS
(Course Code:26PPHEC4)

IInd YEAR	ECC 4	Hours 3	Credits 3
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Course Outcomes: At the end of the course the students must be able to

- CO1** To develop knowledge in the basics of lasers (K1)
- CO2** To enhance comprehension in the principles of lasers (K2)
- CO3** To explore the control of laser properties (K3)
- CO4** To familiarize with the diverse applications of lasers (K4)
- CO5** To analyse the lasing mechanisms of lasers (K5)
- CO6** To know the importance of electro optic and acousto optic effects (K6)

UNIT 1: WAVE PROPAGATION IN ANISOTROPIC MEDIA

Double refraction – plane waves in an isotropic media – wave refractive index – ray refractive index – the ray velocity surface – The index ellipsoid.

UNIT 2: LASING MECHANISM I

The Einstein Coefficients-Light amplification-The threshold condition-Laser rate Equations Variation of laser power around Threshold – Optimum output coupling –Line broadening mechanisms.

UNIT 3: LASING MECHANISM II

Modes of a rectangular cavity and the open planar resonator-The quality factor-The ultimate line width of the laser-Mode selection-Q-switching-Mode locking in lasers- -Higher order modes- Ruby lasers-Neodymium based lasers – The He-Ne laser-The argon ion laser-CO₂ laser–Dye lasers – Excimer lasers-Semiconductor lasers.

UNIT 4: ELECTRO OPTIC AND ACOUSTO-OPTIC EFFECTS

Index ellipsoid in the presence of an external electric field-Electro optic effect in KDP crystal: Longitudinal mode- Raman Nath and Bragg regimes of diffraction –Acousto-optic spectrum analyser

UNIT 5: NON-LINEAR OPTICAL PHENOMENA

Harmonic Generation–Second Harmonic Generation– Phase Matching Third Harmonic Generation – Optical Mixing – Parametric Generation of Light.

BOOKS FOR STUDY:

1. Optical electronics A.K.Ghatak and K.Thyagarajan, Cambridge University Press 1991.

BOOKS FOR REFERENCE:

1. Principles of Lasers and Optics, William S.C.Chang, Cambridge University Press, 2005