ST THOMAS COLLEGE PALAI

AUTONOMOUS ESTD. 1950 REACCREDITED BY NAAC WITH A++ GRADE

UNDERGRADUATE PROGRAMMES (HONOURS) SYLLABUS

STCP-UGP (HONOURS)

(2024 ADMISSION ONWARDS)

FACULTY : SCIENCE

PROGRAMME : B.Sc. (HONOURS) PHYSICS

ST THOMAS COLLEGE PALAI AUTONOMOUS
ARUNAPURAM P.O., PALA, KOTTAYAM - 686 574
KERALA, INDIA

ST THOMAS COLLEGE PALAI AUTONOMOUS
UNDERGRADUATE PROGRAMMES (HONOURS) SYLLABUS

STCP-UGP (Honours)

(2024 Admission Onwards)

Faculty: Science

BoS: Physics

Programme: Bachelor of Science (Honours) Physics

St Thomas College Palai Autonomous
Arunapuram, Kottayam-686574
Kerala, India

Contents

Preface

The U G (Hons) syllabus in Physics incorporates emerging trends in various advanced fields of Physics. This program is designed to provide an in-depth understanding of the subject, enhanced by tutorials and problem-solving initiatives, to equip students for appearing in competitive exams, pursuing higher studies and employment in any branches of Physics and related areas. It also serves as a bridge between theoretical knowledge and its practical implementation.

The program also aims to:

(i) Provide top-quality education in Physics at the undergraduate level, producing graduates of a caliber sought after by industries, public service, and future academic teachers and researchers.

(ii) Attract outstanding students from diverse backgrounds.

(iii) Offer an intellectually stimulating environment where students can develop their skills and passions to their fullest potential.

(iv) Maintain the highest academic standards in undergraduate teaching.

(v) Impart the skills necessary to gather and utilize information from various resources.

(vi) Equip students with methodologies related to Physics

The program imparts knowledge through the Discipline Specific Courses (DSC), Discipline Specific Electives (DSE), Multi-Disciplinary Courses (MDC), Skill Enhanced Courses (SEC), Value Added Courses (VAC) that form the foundation of Physics.

The DSE's and MDC's offered are designed for specialized and interdisciplinary content, providing students with a broader knowledge base. Students are encouraged to develop creative thinking, research aptitude, and a strong work ethic, preparing them to pursue higher education in prestigious universities, institutions or laboratories. The practical syllabus is also structured to reflect advancements in various fields of physics and technology.

St Thomas College Palai Autonomous was conferred autonomous status by the UGC on 19 January 2024 and subsequently Mahatma Gandhi University, Kottayam after due procedure, notified it only on May 7, 2024, which resulted in the delay of the constitution of various statutory bodies (Governing Body, Academic Council and Board of Studies) of our

College. Therefore, the first Academic Council of St Thomas College Palai Autonomous held on 10 June 2024 decided to adopt the syllabus of Mahatma Gandhi University for the UG programmes of our college for the academic year 2024–25.

Syllabus Index

Name of the Major: **Physics**

Semester: 1

Course Code	Title of the Course	Type of the Course	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
24U1PHYDSC100	Foundations of Physics	DSC A	4	5	3	0	2	0
24U1PHYMDC100	Physics around you	MDC	3	4	2	0	2	0

L — Lecture, T — Tutorial, P — Practical/ Practicum, O — Others

Semester: 2

Course Code	Title of the Course	Type of the Course	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
24U2PHYDSC100	Modern Physics	DSC A	4	5	3	0	2	0
24U2PHYMDC100	Observational Astronomy	MDC	3	4	2	0	2	0

Semester: 3

Course Code	Title of the Course	Type of the Course	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
24U3PHYDSC200	Principles of Mechanics	DSC A	4	5	3	0	2	0
24U3PHYDSC201	Essential Mathematics for Physics	DSC A	4	4	4	0	0	0
24U3PHYDSE200	Basic Semiconductor Physics (Semiconductor Physics Specialization)	DSE Any one	4	5	3	0	2	0
24U3PHYDSE201	Computational Physics- C++ Programming (Computational Physics Specialization)							
24U3PHYDSE202	Introduction to Space Physics (Space Physics Specialization)							
24U3PHYDSE203	Introduction to Optics (Photonics Specialization)							
24U3PHYDSE204	Introduction to Materials Science (Materials science Specialization)							
24U3PHYDSE205	Foundations of Theoretical Physics (Theoretical Physics Specialization)							
24U3PHYDSE205	Microcontroller Programming (Electronic Systems and Programming Specialization)							

24U3PHYDSE207	Properties of Matter							
24U3PHYDSC202	Atomic and Molecular Spectroscopy.	DSC B	4	5	3	0	2	0
24U3PHYMDC200	Renewable Energy Sources	MDC	3	3	3	0	0	0
24U3PHYVAC200	Science and Society	VAC	3	3	3	0	0	0

Semester: 4

Course Code	Title of the Course	Type of the Course	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
24U4PHYDSC200	Wave Optics	DSC A	4	5	3	0	2	0
24U4PHYDSC201	Electromagnetic Theory	DSC A	4	4	4	0	0	0
24U4PHYDSE200	Semiconductor Electronics (Semiconductor Physics Specialization)	DSE Any one	4	5	3	0	2	0
24U4PHYDSE201	Numerical Methods for Computational Physics (Computational Physics Specialization)							
24U4PHYDSE202	Exploring the Cosmos: Observations, Celestial Bodies, and Cosmic Evolution (Space Physics Specialization)							
24U4PHYDSE203	Optoelectronics (Photonics Specialization)							
24U4PHYDSE204	Material Characterisation Techniques. (Materials Science Specialization)							

24U4PHYDSE205	Theory of Relativity (Theoretical Physics Specialization)							
24U4PHYDSE205	Continuous and Discrete Systems (Electronic Systems and Programming Specialization)							
24U4PHYDSE207	Current Electricity							
24U4PHYDSC202	Basic Electronics and Electricity	DSC B	4	5	3	0	2	0
24U4PHYSEC200	Electrical Circuits and Network Skills	SEC	3	3	3	0	0	0
24U4PHYVAC200	Environmental Physics	VAC	3	3	3	0	0	0
24U4PHYINT200	Internship	INT	2					

Semester: 5

Course Code	Title of the Course	Type of the Course	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
24U5PHYDSC300	Classical Mechanics	DSC A	4	4	4	0	0	0
24U5PHYDSC301	Introductory Quantum Mechanics	DSC A	4	4	4	0	0	0
24U5PHYDSC302	Atomic and Molecular Physics	DSC A	4	4	4	0	0	0
24U5PHYDSE300	Semiconductor Optoelectronic Devices (Semiconductor Physics Specialization)	DSE any two	4	5	3	0	2	0

24U5PHYDSE301	Computational Physics: Python (Computational Physics Specialization)							
24U5PHYDSE302	Physics of atmosphere (Space Physics Specialization)							
24U5PHYDSE303	Laser, Non-linear Optics and Fiber Optics. (Photonics Specialization)							
24U5PHYDSE304	Physics of Advanced Materials (Materials Science Specialization)							
24U5PHYDSE305	Introduction to Group Theory (Theoretical Physics Specialization)							
24U5PHYDSE310	Robotics and Industrial Automation (Electronic Systems and Programming Specialization)							
24U5PHYDSE307	Op amp and Linear Integrated Circuits							
24U5PHYSEC300	Solar Cell Technology: From Fundamentals to Applications	SEC (Any One)	3	3	3	0	0	0
24U5PHYSEC301	Physics Using Computational Tools							

Semester: 6

Course Code	Title of the Course	Type of the Course	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
24U6PHYDSC300	Introduction to Solid State Physics	DSC A	4	5	3	0	2	0
24U6PHYDSC301	Thermal and Statistical Physics	DSC A	4	5	3	0	2	0
24U6PHYDSE300	Sensors and actuators (Semiconductor Physics Specialization)	DSE (Any Two)	4	4	4	0	0	0
24U6PHYDSE301	Applied Computational Techniques in Chaos theory (Computational Physics Specialization)							
24U6PHYDSE302	Introduction to Plasma Physics (Space Physics Specialization)							
24U6PHYDSE303	Nanophotonics (Photonics Specialization)							
24U6PHYDSE304	Nanostructured Materials and its Applications (Materials Science Specialization)							
24U6PHYDSE305	Classical Theory of Fields (Theoretical Physics Specialization)							
24U6PHYDSE310	Advanced Power System Design							

	(Electronic Systems and Programming Specialization)							
24U6PHYDSE307	Introduction to Nuclear Physics							
24U6PHYSEC300	Introduction to Cross Platform Mobile Application Development using Flutter	SEC (Any One)	3	4	2	0	2	0
24U6PHYSEC301	Essential Machine Learning for Physicists							
24U6PHYVAC300	Physics for Resilience: Strategies in Disaster Management	VAC (Any One)	3	3	3	0	0	0
24U6PHYVAC301	Environmental Physics and Human Rights							

Semester: 7

Course Code	Title of the Course	Type of the Course	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
24U7PHYDCC400	Statistical Physics	DCC	4	5	3	0	2	0
24U7PHYDCC401	Mathematical Physics	DCC	4	4	4	0	0	0
24U7PHYDCC402	Electrodynamics	DCC	4	4	4	0	0	0
24U7PHYDCE400	Nuclear and Particle Physics	DCE	4	4	4	0	0	0
24U7PHYDCE401	Radiation Physics							
24U7PHYDCE402	Classical Mechanics II	DCE	4	4	4	0	0	0
24U7PHYDCE403	Research Methodology							
24U7PHYDCE404	Biophotonics	DCE	4	4	4	0	0	0
24U7PHYDCE405	General Relativity							

Semester: 8

Course Code	Title of the Course	Type of the Course	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
24U8PHYDCC400	Quantum Mechanics	DCC	4	5	3	0	2	0
24U8PHYDCC401	Condensed Matter Physics	DCC	4	5	3	0	2	0
24U8PHYDCE400	Quantum Field Theory	DCE	4	5	3	0	2	0
24U8PHYDCE401	Nonlinear Dynamics							
24U8PHYDCE402	Introduction to Quantum Computation and Information Theory							
24U8PHYPRJ400	Project (Honours/ Honours with Research)	PRJ	12					

SEMESTER 1

St Thomas College Palai Autonomous

Programme	**BSc (Hons) Physics**					
Course Name	**Foundations of Physics**					
Type of Course	**DSC A**					
Course Code	**24U1PHYDSC100**					
Course Level	**100**					
Course Summary	This course aims to provide a strong foundation of Physics and equip the students to be familiar with the methodology of Physics. It also throws light to basic laws of mechanics and its application. This course also provides a hands on experience in programming using Python.					
Semester	1	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	1	0	75
Pre-requisites if any	Nil					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	To apply vector algebra to physical problems.	U, A	1, 2
2	To apply the concepts of distance, time, mass, and accelerated motion.	A	1, 2
3	To illustrate the basic ideas of Newtonian Mechanics	U, A, An	1, 2
3	To apply the concepts of work, energy and power in practical problem solving	U, An	1, 2
4	To familiarise the concept of programming using Python	U, A, S	1, 2

5	To acquire the basic knowledge of error analysis and to get hands on expertise in using basic components and equipment in Physics lab	U, A, An, S	1, 2
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom Transaction (Units)

Module	**Units**	**Course description**	**Hrs**	**CO No.**
1	**How Physics Describe Things**		**14**	
	1.1	The Nature of Physics, Solving Physics Problems, Standards and Units, Consistency and Conversions, Uncertainty and Significant Figures, Estimates and Orders of Magnitude	2	1
	1.2	Vectors and Vector Addition, Components of Vectors, Unit Vectors, Products of Vectors	2	2
	1.3	Displacement, Time, Average and Instantaneous Velocity, Average and Instantaneous Acceleration	2	3
	1.4	Motion with constant acceleration, Freely Falling Bodies, Velocity and Position by Integration	3	3
	1.5	Position and velocity vectors, The acceleration vector	2	3
	1.6	Projectile motion, Motion in a Circle, Relative Velocity	3	3
2	**2.1 Newton's Laws of Motion and its Applications**		**13**	
	2.1.1	Force and Interactions, Newton's First Law, Newton's Second Law	2	3
	2.1.2	Mass and Weight, Newton's Third Law, Free-Body Diagrams	2	3
	2.1.3	Newton's Laws- Applications	7	3
	2.1.4	Frictional force	2	3

	2.2 Energy and Energy Conservation		**10**	
	2.2.1	Work, Kinetic Energy and the Work-Energy Theorem	3	4
	2.2.2	Work and Energy with Varying Forces, Power	2	4
	2.2.3	Gravitational Potential Energy, Elastic Potential Energy	2	4
	2.2.4	Conservative and Nonconservative Forces, Force and Potential Energy, Energy Diagrams	3	4
3	**Python as Calculator**		**8**	
	3.1	Introduction to Python, Writing and executing simple Python scripts, Declaring and using variables,	2	5
	3.2	Basic mathematical operations in Python (+, -, *, /, %), Using parentheses for precedence, String Operations, User Input, Conditional Statements	3	5
	3.3	Introduction to for and while loops, Loop control statements (break, continue), Basic list operations (appending, indexing, slicing), Parameters and return statements.	3	5
4	**Practical (Error analysis should be done for experiments 1 to 8)**		**30**	6
	1	Conceptualization of random error and propagation of error by measuring the dimensions of a thin metallic rod (using Screw gauge and Vernier calliper) and hence calculating its volume and surface area.		
	2	Comparison of Screw gauge and Vernier calliper readings by measuring the dimensions of a small object and comparison of Vernier calliper and meter scale readings by measuring the dimensions of a larger object.		
	3	Comparison of microscope and Screw gauge readings by measuring the thickness of a wire.		
	4	Parallelogram law of vector addition and determination of unknown mass/density of a liquid using loss of weight concept.		
	5	Verification of vector addition using force table.		

	6	Laser triangulation- determination of the height of an object using a laser.		
	7	Conceptualization of significant digits and rounding of numbers by measuring the time period of a simple harmonic motion using analogue and digital time keeping devices.		
	8	Identify resistances using colour code and verify using a multimeter. Compare the given tolerance with the measured value. Study the series and parallel resistance of two resistors.		
	9	Building a basic calculator program using Python.		
	10	Simple Programs using Python.		
5	Python for Physics Applications			
	5.1	Conversion between various temperature units, Newton's equations of motion, Maximum height and range of a projectile.		5
	5.2	Simple Harmonic Motion, Physical measurements in acceleration due to gravity, Verification with computational result.		5

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Demonstrations, Animations, Presentations, Discussions, Programming sessions.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA) – 25 Marks** **Theory: 25 marks**

Particulars	**Marks**
Assignments	**5**
Oral Presentation	**5**
Quiz	**5**
Internal assessment tests (TP-1 and TP-2)	**10**
Total	**25**

Practical: 15 marks

Particulars	**Marks**
Laboratory Report	**5**
Practical Skill	**5**
Internal assessment test	**5**
Total	**15**

B. End Semester Examination (ESE)

Theory: 50 marks, duration -1.5 hrs

- Short answer type questions: Answer any 7 questions out of 10(7*2=14)
- Short essay-type questions: Answer any 4 questions out of 6(4*6=24)
- Essay type questions: Answer any 1 question out of 2(1*12=12)

Practical: 35 marks, duration -2 hrs

- Lab Exam: 30 marks
- Record: 5 marks

Textbooks

1. Young, Hugh D., Freedman, Roger A. *University Physics With Modern Physics*. Ed. 14 London: Pearson Education, Inc.2016
2. Olenick, Richard P., et al. *The Mechanical Universe: Introduction to Mechanics and Heat and Beyond the Mechanical Universe: From Electricity to Modern Physics and The Mechanical Universe: Mechanics and Heat* (Advanced Edition) (1987): 98-100.
3. Downey, Allen B. *How to think like a computer scientist: Learning with Python,* Green Tea Press 2003.

References

1. Shankar R. *Fundamentals of Physics I – Mechanics, Relativity, and Thermodynamics* (Open Yale Courses) Yale University Press, 2019.
2. Beiser, Arthur, Mahajan. Shobhit, Choudhury, S. Rai. *Concepts of Modern* Physics. McGraw Hill Education, 2017 7th Edition
3. Krane, Kenneth S. *Modern* Physics. John Wiley & Sons, 2019
4. Frautschi, Steven C. *The mechanical universe: Mechanics and heat*. Cambridge University Press, 1986.
5. Mahendra K Verma *Practical numerical computing using Python* 2021

St Thomas College Palai Autonomous

Programme						
Course Name	**Physics Around You**					
Type of Course	**MDC**					
Course Code	**24U1PHYMDC100**					
Course Level	**100**					
Course Summary	This course, "Physics Around You," provides an engaging exploration of fundamental physics principles manifested in everyday life, trying to connect theoretical concepts and the real-world phenomena that shape our daily experiences. From mastering concepts like units, dimensions, and motion laws to developing expertise in optical phenomena, including reflection and refraction, learners will gain a solid foundation in physics					
Semester	**1**	**Credits**			**3**	**Total Hours**
Course Details	**Learning Approach**	**Lecture**	**Tutorial**	**Practical**	**Others**	
		2	**0**	**1**	**0**	**60**
Pre-requisites, if any	**Nil**					

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains**	**PO No**
1	Students will be able to understand the concepts of elementary mechanics	U	1, 2
2	Students will be able to explain the fundamentals of Electricity	U	1, 2
3	Students will be able to apply optical phenomena in analysing real life situations	A, An	1, 2
4	Students will be able to understand the basic principle, properties and its applications	U	1, 2
5	Students will be able to acquire hands on expertise in the basic electrical and electronic equipment and to demonstrate the basic light phenomena	A, An, S	1, 2
***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S),**			

Interest (I) and Appreciation (Ap)

COURSE CONTENT
Content for Classroom Transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Elementary mechanics**		**15**	
	1.1	Units and Dimensions, conversions of units, Order of magnitude	2	1
	1.2	Motion in a straight line, velocity, acceleration, laws of motion	4	1
	1.3	Work, power, efficiency, kinetic energy, potential energy, conservation of energy.	4	1
	1.4	Waves, properties of waves, sound, speed of sound, doppler effect	5	1
2	**Electricity and Light**		**15**	
	2.1	Electric current, voltage, Ohm's law, resistivity, electric power	5	2
	2.2	Electromagnetic waves, reflection, refraction (twinkling of stars), total internal reflection (sparkling of diamonds, Optical fiber), scattering (blue colour of the sky).	8	3
	2.3	Laser–principle, properties and applications	2	4
3	**Practical**		**30**	
	1	Demonstration of Ohm's law		5
	2	Screw gauge to measure the radius of the wire, the volume of the sphere and the glass piece		5
	3	Vernier calliper to measure the volume of cylinder, sphere		5
	4	Familiarization of digital multimeter to, test the diodes, measuring electrical properties like current, voltage, resistance, capacitance		5
	5	Familiarization of CRO by studying waveforms from a function generator (amplitude, frequency time period of sine square and triangular waves)		5
	6	Modelling and review report on advance in space research in India – Chandrayan mission, Adithya L1		5

	7	Demonstration of standing waves using Melde's string experiment.		5
	8	Demonstration of total internal reflection using Laser.		5
	9	Laser triangulation- determination of the height of an object using a laser.		5
	10	Demonstration of refraction of light through a prism		5
4	**Teacher specific content**			
	4.1	Generation of electricity by - Hydroelectric power, Solar power, Nuclear power, Wind power (quantitative)		2
	4.2	Comparison of energy consumption of electric appliances at home, Methodologies and practices to save electricity		2
	4.3	Applications of light in - Medical arena, Defense, Communications (quantitative)		3
	4.4	Physics behind mirage, Phenomenon and formation of rainbows		3

<table>
<tr><td>Teaching and Learning Approach</td><td>Classroom Procedure (Mode of transaction)
Lecture, Demonstration, Observation, Interactive, E-learning Group discussion</td></tr>
<tr><td>Assessment Types</td><td>MODE OF ASSESSMENT
A. Continuous Comprehensive Assessment (CCA)
Theory:15 marks
<table>
<tr><th>Particulars</th><th>Marks</th></tr>
<tr><td>Assignment</td><td>5</td></tr>
<tr><td>Seminar/ Oral presentation</td><td>5</td></tr>
<tr><td>Internal Assessment tests (TP-1 & TP-2)</td><td>5</td></tr>
<tr><td>Total</td><td>15</td></tr>
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Practical:15 marks
<table>
<tr><th>Particulars</th><th>Marks</th></tr>
<tr><td>Lab involvement/ Practical skill</td><td>5</td></tr>
<tr><td>Viva/ MCQ</td><td>5</td></tr>
<tr><td>Internal assessment test</td><td>5</td></tr>
<tr><td>Total</td><td>15</td></tr>
</table>
</td></tr>
</table>

	B. End Semester Examination (ESE) **Theory: 35 marks, duration 1.5 hrs** ● MCQ exams **Practical: 35 marks, duration 2 hrs** ● Lab Exam:30 marks ● Record: 5 marks

Textbooks

1. Beiser, Arthur. Schaum's Easy Outline of Applied Physics, Revised Edition McGraw-Hill Education, 2011
2. Hewitt, Paul G. Conceptual Physics. Pearson Education, 2002.
3. Chattopadhyay, D., and Rakshit, P. C. An Advanced Course In Practical Physics. India, New Central Book Agency, 1990.

References

1. Lewin, Walter, and Warren Goldstein. *For the Love of Physics: From the End of the Rainbow to the Edge of Time-A Journey through the Wonders of Physics*. Simon and Schuster, 2011.
2. Shukla, R K. Practical Physics. India, New Age International (P) Limited, Publishers, 2007.

SEMESTER 2

St Thomas College Palai Autonomous

<table>
<tr><td>Programme</td><td colspan="6">BSc (Hons) Physics</td></tr>
<tr><td>Course Name</td><td colspan="6">Modern Physics</td></tr>
<tr><td>Type of Course</td><td colspan="6">DSC A</td></tr>
<tr><td>Course Code</td><td colspan="6">24U2PHYDSC100</td></tr>
<tr><td>Course Level</td><td colspan="6">100</td></tr>
<tr><td>Course Summary</td><td colspan="6">This course is an overview of the developments in Physics in the 20th century. The discussion of Einstein's theory of Relativity, Quantum theory of light, the Dual nature of matter, Light matter interaction will help the student to develop a broad knowledge in Modern physics.</td></tr>
<tr><td>Semester</td><td>2</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>3</td><td>0</td><td>1</td><td>0</td><td>75</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">Nil</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	To acquire in depth knowledge on the Special theory of relativity and its applications	U, A	1, 2
2	To illustrate the dual nature of matter and radiation and importance of De-Broglie hypothesis in the development of quantum mechanics	U, A	1, 2
3	To explain the different atomic models and the atomic structure	U	1, 2
4	To appreciate the effects of the structure of matter.	U, Ap	1, 2
5	To understand the basic concepts leading to quantum physics.	U	1, 2

6	To gain hands on expertise in experiments related to modern physics	S, A, An	1, 2

****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Theory of Relativity**		**10**	
	1.1	Frames of Reference, Postulates of Special Relativity	1	1
	1.2	Length Contraction, Time Dilation and Twin Paradox	3	1
	1.3	Doppler Effect and the Expanding Universe	3	1
	1.4	Mass Energy Relation, General Theory of Relativity.	3	1
2	**2.1 Particle properties of waves**		**8**	
	2.1.1	Electromagnetic waves, Blackbody Radiation, Planck's quantum theory of radiation	3	2
	2.1.2	Photoelectric effect, Quantum Theory of Light	2	2
	2.1.3	X-rays, Compton Effect, Pair Production	3	2
	2.2 Wave Properties of Particles		**7**	
	2.2.1	De Broglie's Waves, Wave function, Describing a wave using general wave formula.	3	2
	2.2.2	Davisson–Germer experiment	2	2
	2.2.3	Heisenberg Uncertainty Principle: mathematical form.	2	2
3	**3.1 Atomic Structure and Applications of Quantum Mechanics**		**10**	
	3.1.1	Bohr atom model, Electron Orbits, Atomic Spectra, Orbital Radii in Bohr Atom, Vector Atom Model	3	3
	3.1.2	Energy Level and Spectra of Atoms, Origin of line spectra, Hydrogen spectrum.	2	3

	3.1.3	LASER: basic properties, stimulated absorption, spontaneous and stimulated emissions, population inversion, Practical Lasers. Band Theory of Solids, Superconductivity.	5	4
	3.2 Introduction to Quantum Mechanics		**10**	
	3.2.1	Wave functions and wave equation.	2	5
	3.2.2	Schrodinger Equation – Time dependent form	1	5
	3.2.3	Expectation values and Operators	2	5
	3.2.4	Schrodinger equation - Steady state form	1	5
	3.2.5	Particle in a box, Nanostructures	4	5
4	**Practical**		**30**	6
	1	Refractive index of water using laser (by forming circular ring).		
	2	Plotting of waveforms using GeoGebra (Sine wave, Cosine Wave etc) and understanding of phase relationships.		
	3	Determine the angle of the given prism using a spectrometer.		
	4	Measure the thickness of a thin wire using a travelling microscope.		
	5	Solar cell- understanding of power generation- measure the output current and voltage for a fixed load for two different intensities and plot the V-I graph		
	6	Study the climate parameters (temperature, pressure, humidity) at a location from satellite data (MOSDAC) and graphically represent the same over a period of time.		
	7	Verification of Stefan's law using low power (DC) incandescent lamp.		
	8	Determination of least count of a ruler using laser – Reflection grating.		
	9	Plot the black body spectrum using a Python program for different temperatures.		
	10	Plot superposition of two sine waves of different frequencies using Python.		

5	**Transformations and Concepts in Relativity Theory**			
	5.1	Galilean transformation, Lorentz transformation, Inverse Lorentz transformation		1
	5.2	Velocity addition, Simultaneity		1

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Demonstrations, Presentations, Discussions
Assessment Types	**MODE OF ASSESSMENT**

MODE OF ASSESSMENT

A. Continuous Comprehensive Assessment (CCA) – 25 Marks

Theory: 25 marks

Particulars	**Marks**
Assignments	**5**
Oral Presentation	**5**
Quiz	**5**
Internal assessment tests (TP-1 and TP-2)	**10**
Total	**25**

Practical: 15 marks

Particulars	**Marks**
Laboratory Report	**5**
Practical Skill	**5**
Internal assessment test	**5**
Total	**15**

B. End Semester Examination

Theory: 50 marks, duration 1.5 hrs

- Short answer type questions: Answer any 7 questions out of 10(7*2=14)
- Short essay-type questions: Answer any 4 questions out of 6(4*6=24)
- Essay type questions: Answer any 1 question out of 2(1*12=12)

Practical: 35 marks, duration 2 hrs

- Lab Exam:30 marks
- Record: 5 marks

Textbook

1. Beiser, Arthur, Mahajan. Shobhit, Choudhury, S. Rai. Concepts of modern physics. McGraw Hill Education, 2017 7th Edition

References

1. Tipler, Paul A., and Llewellyn, Ralph A., Modern Physics, W. H. Freeman and Company, 2008. https://web.pdx.edu/~pmoeck/books/Tipler_Llewellyn.pdf
2. Young, Hugh D., Roger A. Freedman, and Ragbir Bhathal. University physics: Australian edition. Pearson Higher Education AU, 2010.Krane,
3. Kenneth S. Modern physics. John Wiley & Sons, 2019.
4. Shankar R. Fundamentals of Physics II – Electromagnetism, Optics, and Quantum Mechanics: The Open Yale Courses Series) Yale University Press 2019.

St Thomas College Palai Autonomous

Programme						
Course Name	**Observational Astronomy**					
Type of Course	**MDC**					
Course Code	**24U2PHYMDC100**					
Course Level	**100**					
Course Summary	The course is structured to spark curiosity among the students and encourage them to explore and appreciate the vastness of the universe using diverse tools of astronomy. The course immerses students in the vast realm of astronomy, imparting a deep understanding of astronomical scales, positional concepts, and the evolution of stars. It further equips learners with the skills to identify celestial objects, constellations, and galaxies, as well as handling tools for observational astronomy.					
Semester	2	Credits			3	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		2	0	1	0	60
Pre-requisite, if any	Nil					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	To comprehend astronomical scales and basic concepts of positional astronomy	U	1
2	To gain knowledge on different telescopes used in the visible part of the spectrum and other electromagnetic bands.	U	1, 2
3	To analyse the different stages in the evolution of star	U, An	1, 2
4	To identify the different galaxies, constellations and the salient	U	1, 2

	features		
5	To categorise the diverse objects in the Solar system	U	1
6	To gain expertise in handling different tools for observational astronomy	U, A, An	1, 2

****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***

COURSE CONTENT

Content for Classroom Transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**1.1 Observational Astronomy**		**8**	
	1.1.1	Introduction to astronomy, Astronomical distances- Astronomical unit, Light year- Scale of the universe	3	1
	1.1.2	Introduction to constellation - Orion (Equitorial), Ursa Major (North circumpolar), Crux (South circumpolar)	5	1, 4
	1.2 Tools for Observational Astronomy		**7**	
	1.2.1	Electromagnetic spectrum, Types of telescopes- optical Telescopes-Reflective telescopes, Refractive telescopes - Hubble Space Telescope, James Webb Space Telescopes. Radio telescopes- GMRT.	7	2
2	**2.1 Stars and galaxies**		**8**	
	2.1.1	Stars-Classification of stars based on temperature.	2	3
	2.1.2	Stellar Masses (Chandrasekhar limit) - Birth of stars, Nebula, Protostar, Main sequence star, Red giant, Death Stages- White Dwarf, SuperNova- Neutron star- Black hole.	4	3
	2.1.3	Galaxy-Classification of Galaxies- Milky Way.	2	4
	2.2 Exploring Solar System		**7**	

	2.2.1	Objects in Solar Systems- Sun, Planets, Asteroids, Comets, Meteors. Exoplanets	4	5
	2.2.2	Eclipses- Solar Eclipses, Lunar Eclipses, Lunar Phases	3	5
3	**Practical**		**30**	6
	1	Familiarization of telescopes and focusing the objects using a telescope		
	2	Illustration of visible spectrum using prism and telescope**.**		
	3	Virtual observatory exploration		
	4	Making models of astronomical phenomena and objects		
	5	Identifying and documenting planets/stars		
	6	Find the Orion Constellation. Name three stars in the belt and prepare a report of these stars as pointer stars		
	7	Mapping and categorization of constellations		
	8	Observe and sketch the map of constellations observable in any one night		
	9	Moon Phase calendar- Have students create a personalized moon phase calendar for a month. They can sketch the moon's appearance each night and note the date, enhancing their observational skills.		
	10	Starry Night Picnic- Organize a casual evening picnic where students can gaze at the night sky, and identify constellations using a stargazing app.		
	11	Learn to use Astronomy software - Any two activities of identification		

	12	Astrophotography-Night Sky Photography		
	13	Telescope making workshop		
	14	Observatory visit		
	15	Observe and Identify Sunspots		
4	**Teacher specific content**			
	4.1	Establishment and progression of Indian Space Research Organization (ISRO) during the last 50+ years [Brief history]		
	4.2	ISRO - Present projects (Chandrayaan 3, Aditya L1) and Future plans (Gaganyaan 3, Chandrayaan-4, Bharatiya Antariksha Station, Mangalyaan 2)		2, 6
	4.3	Recent upshots from James Webb Space Telescope		2

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, Demonstration, Field Trip, Observation, Group discussion.

Assessment Types

MODE OF ASSESSMENT

A. Continuous Comprehensive Assessment (CCA)

Theory:15 marks

Particulars	**Marks**
Assignment	5
Seminar/ Oral presentation	5
Internal Assessment tests (TP-1 & TP-2)	5
Total	**15**

Practical:15 marks

Particulars	**Marks**
Lab involvement/ Practical skill	5

Viva/ MCQ	5
Internal assessment test	5
Total	**15**

B. Semester End Examination

Theory: 35 marks, duration 1.5 hrs

- MCQ exams

Practical: 35 marks, duration 2 hrs

- Lab Exam: 30 marks
- Record: 5 marks

Textbooks

1. Moché, Dinah L. Astronomy. A self-teaching guide. Seventh Edition, John Wiley and Sons 1993.
2. Basu, Biman Joy of star watching by, National Book Trust, India 2017.

References

1. Morrison, Ian Introduction to Astronomy and Cosmology , John Wiley & Sons Inc; 1st edition 2008.
2. Moore, Patrick An amateur astronomer 12th edition, Springer 2006.
3. Astronomy, Openstax, Rice University (Free Astronomy book) 2nd Edition 2022

SEMESTER 3

St Thomas College Palai Autonomous

Programme	**BSc (Hons) Physics**					
Course Name	**Principles of Mechanics**					
Type of Course	**DSC A**					
Course Code	**24U3PHYDSC200**					
Course Level	**200**					
Course Summary	This course covers fundamental principles in Classical Mechanics, beginning with Newton's Laws of Motion. It explores the concepts of inertia, Newton's second law, and the equal and opposite action-reaction principle. The study extends to analyzing motion under various force scenarios, including constant force, time-dependent force, velocity-dependent force, and position-dependent force, with a focus on simple harmonic motion. Additionally, the course delves into rotational dynamics, covering angular momentum conservation, rigid body rotation, and central force motion, including the application of Kepler's laws to describe planetary motion within a gravitational field.					
Semester	3	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	1	0	75
Pre-requisite, if any	Nil					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	To solve equations of motion for different types of forces	U, A, E	1, 2
2	To understand Newton's law of Gravitation	U	1, 2

3	To analyse the simple harmonic motion	A, E	1, 2
4	To distinguish between different types of damping	U, A	1, 2
5	To analyse forced harmonic oscillation	U, An	1, 2
6	To illustrate the dynamics of rotation.	A, An, E	1, 2
7	To analyse the motion under central force.	U, An	1, 2
8	To apply and analyse the laws of mechanics in various experiments.	U, A, An	1, 2
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom Transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Newton's Laws: Determining the Motion**		**15**	
	1.1	Review of Newton's laws of motion.	2	1
	1.2	Determining the motion for different types of forces- constant force, force as a function of time, force as a function of velocity, force as a function of position-simple harmonic motion.	6	1
	1.3	Newton's law of universal gravitation, the gravitational field, gravitational field of an extended body, gravitational potential, field lines and equipotential surfaces.	7	2
2	**Harmonic Motion**		**12**	
	2.1	Springs and pendulum, solving the differential equations, example-mass on a spring,	4	3
	2.2	The damped harmonic oscillator, the underdamped oscillator, the overdamped oscillator and the critically damped oscillator.	4	4
	2.3	Forced harmonic oscillator-obtaining solution	4	5

3	**Rotational Dynamics and Central Force Motion**		**18**	
	3.1	Definition of angular momentum, conservation of angular momentum, angular momentum of a system of particles, angular momentum relative to the centre of mass, rotation of a rigid body about a fixed axis.	6	6
	3.2	A linearly accelerating reference frame, a rotating coordinate frame, fictitious forces, centrifugal forces and the Plumb bob, the Coriolis force	6	6
	3.3	Kepler's laws, central forces, the equation of motion, energy and the effective potential, Solving the equations of motion, equation of orbit.	6	7
4	**Practical**		**30**	**8**
	1	Length of simple pendulum equivalent to a symmetric compound pendulum.		
	2	Determination of moment of inertia of a bar		
	3	Determination of moment of inertia of a flywheel.		
	4	Determination of the length of simple pendulum equivalent to a Kater's pendulum		
	5	Determination of moment of inertia of a disc using a torsion pendulum.		
	6	Study the motion of a string and calculate i) spring constant and ii) acceleration due to gravity.		
	7	Length of simple pendulum equivalent to an asymmetric compound pendulum.		
	8	Compute and plot the motion of a particle under the action of the central force $F = -K/r^3\ (1-\alpha/r)r$, where α and K are constants. Show that this orbit precesses. Show how your choice of α and K affects the motion.		
	9	Develop a Python program for solving and visualizing the dynamics of a harmonic oscillator.		
	10	Develop a Python program for solving and visualizing the dynamics of a damped harmonic oscillator under different damping conditions.		

5	**Teacher specific content**	

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Demonstrations, Presentations, discussions
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 marks** **Formative assessment** ● Quiz ● Assignment ● Seminar **Summative assessment** ● Written test **Practical: 15 marks** ● Lab involvement ● Viva
	B. End Semester Examination **Theory: 50 marks, duration 1.5 hrs** ● Short answer type questions: Answer any 7 questions out of 10(7*2=14) ● Short essay-type questions: Answer any 4 questions out of 6(4*6=24) ● Essay type questions: Answer any 1 question out of 2(1*12=12) **Practical: 35 marks, duration 2 hrs** ● Lab Exam:30 marks ● Record: 5 marks

Textbook

1. Patrick Hamill, Intermediate Dynamics, Jones and Bartlett India Private Limited 2009.

References

1. Shankar R. Fundamentals of Physics I – Mechanics, Relativity, and Thermodynamics (Open Yale Courses) Yale University Press, 2019.
2. Mathur, D. S. Mechanics. S. Chand Publishing, 2000.
3. Kleppner, Daniel, and Robert Kolenkow. An introduction to mechanics. Cambridge University Press, 2014.
4. Young, Hugh D., Roger A. Freedman, and Ragbir Bhathal. University physics: Australian edition. Pearson Higher Education AU, 2010. https://link.springer.com/book/10.1007/978-3-030-15195-9 (open access textbook by Springer)

St Thomas College Palai Autonomous

Programme	**BSc (Hons) Physics**					
Course Name	**Essential Mathematics for Physics**					
Type of Course	**DSC A**					
Course Code	**24U3PHYDSC201**					
Course Level	**200**					
Course Summary	This course in "Essential Mathematics for Physicists" offers an exploration of fundamental mathematical concepts, emphasizing vectors, matrices, and vector algebra, providing students with essential tools for advanced studies in physics. Through rigorous instruction, students develop proficiency in mathematical techniques crucial for solving complex problems encountered in various branches of physics.					
Semester	3	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre-requisites if any	Higher Secondary School level knowledge in Mathematics					

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	To understand and apply advanced concepts of vector algebra.	U	1, 2
2	To analyze and manipulate matrices with a focus on special types.	A, An	1, 2
3	To understand and apply eigenvectors and eigenvalues	U	1, 2
4	To apply vector calculus in real-world physical scenarios.	A,	1, 2

5	To solve problems involving curvilinear coordinates and coordinate transformations.	A, An	1, 2
6	To evaluate line, surface, and volume integrals, applying the divergence and Stokes' theorems.	An, E	1, 2
7	To apply mathematical methods to solve physical problems, enhancing problem-solving skills in physics.	A	1, 2
***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)**			

COURSE CONTENT

Content for Classroom Transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Concepts of Vector Algebra**		**14**	
	1.1	Review of Basic Vector Algebra, Physical significance of Scalar and Vector product. Physical significance of Scalar and Vector triple product	5	1, 7
	1.2	Equations of lines, planes and spheres, Using vectors to find distances, Reciprocal vectors	3	1, 7
	1.3	Physical Concepts of Vector spaces, Basis vectors, Inner product	3	1, 7
	1.4	Inequalities in vector space (no need of derivations), Linear operators, Orthogonality, Orthonormality of base vectors, Orthogonalization of vectors	3	1, 7
2	**Matrices**		**16**	
	2..1	Basic matrix algebra - Direct Sum and direct product of matrices, The transpose and conjugates of a matrix, The trace of a matrix, The determinant of a matrix	3	2, 7
	2.2	The inverse of a matrix, The rank of a matrix, Simultaneous linear equations	3	2, 7

	2.3	Special types of square matrix- Diagonal matrices, Lower and upper triangular matrices, Symmetric and antisymmetric matrices, Orthogonal matrices, Hermitian and anti-Hermitian matrices, Unitary matrices-Normal matrices	3	2, 7
	2.4	Eigenvectors and eigenvalues, Eigenvectors and eigenvalues of a normal matrix, Hermitian and Anti-Hermitian, unitary matrices and general square matrix, Simultaneous eigenvectors	4	3, 7
	2.5	Determination of eigenvalues and eigenvectors, Change of basis and similarity transformations, Diagonalisation of matrices,	3	3, 7
3	**Vector calculus**		**15**	
	3.1	Differentiation of vectors, Differentiation of composite vector expressions, Differential of a vector, Integration of vectors, Vector functions of several arguments, Surfaces, Scalar and vector fields	3	4, 7
	3.2	Vector operators and its geometrical interpretation. Physical concept of Gradient, Divergence and Curl. Gradient of a scalar field, Divergence of a vector field, Curl of a vector field.	4	4, 7
	3.3	Vector operator formulae, Vector operators acting on sums and products, Combinations of grad, div and curl	4	4, 7
	3.4	General curvilinear coordinates, Curvilinear coordinate system-Cartesian, Cylindrical and Spherical polar coordinate system. Gradient, divergence, curl and Laplacian in spherical system. (expressions only)	4	4, 5, 7
4	**Line, surface and volume integrals**		**15**	
	4.1	Line integrals, Evaluating line integrals, Physical examples of line integrals, Line integrals with respect to a scalar, Connectivity of regions.	5	6, 7
	4.2	Green's theorem in a plane, Conservative fields and potentials, Surface integrals, Evaluating surface integrals, Vector areas of surfaces, Physical examples of surface integrals.	5	6, 7

	4.3	Volume integrals, Integral forms for grad, div and curl, Divergence and Green's theorems. Physical applications of the divergence theorem, Stokes' theorem and its Physical applications	5	6, 7
5	**Teacher specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Demonstrations, Problem sheets, Presentations and Discussions
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 marks** **Formative assessment** ● Quiz ● Assignments ● Seminar **Summative assessment** ● Written tests
	B. End Semester Examination (Theory based Examination) **Total: 70 marks, duration 2 hrs** ● Short answer type questions: Answer any 10 questions out of 12(10*3=30) ● Short essay type questions: Answer any 4 questions out of 6(4*7=28) ● Essay type questions: Answer any 1 question out of 2(1*12=12)

Textbook

1. Riley, Kenneth Franklin, and Hobson, Michael Paul “Foundation mathematics for the physical sciences”. Cambridge University Press, 2011.

References

1. Kreyszig, Erwin. Advanced Engineering Mathematics 9th Edition with Wiley Plus Set. John Wiley & Sons, (2007).
2. Arfken, George B., Hans J. Weber, and Frank E. Harris. Mathematical methods for physicists: a comprehensive guide. Academic press, (2011).
3. Bence S. J., K. F. Riley, and M. P. Hobson. "Mathematical methods for physics and engineering." (2006).
4. Apostol Tom M Calculus Vol I and Vol II John Wiley & Sons, (1991)
5. Thomas, George B., Hass, Joel. Davis. Heil, Christopher and Weir Maurice D. Thomas' Calculus, Pearson Education; Fourteenth edition (2018)

St Thomas College Palai Autonomous

Programme	**BSc (Hons) Physics**					
Course Name	**Basic Semiconductor Physics**					
Type of Course	**DSE**					
Course Code	**24U3PHYDSE200**					
Course Level	**200**					
Course Summary	This course gives an overview of the various circuit parameters and components involved in electronics. This course also provides a comprehension of the fundamentals of diodes and transistors and their applications.					
Semester	**3**	Credits			**4**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	**0**	**1**	**0**	**75**
Pre-requisites, if any	Basic knowledge in semiconductors.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	To identify the characteristics of forward and reverse biasing	K	1, 2, 3
2	To design circuits using Zener diodes for specific voltage regulation requirements.	A	1, 2, 3
3	To understand rectification and to design rectifying circuits with and without filter circuits	U,A,E	1, 2, 3

4	To analyse the characteristics of CB and CE configurations in transistor biasing for evaluating current and voltage gain	U, An,E	1, 2, 3
5	To understand and design feedback circuits for amplifiers and oscillators	U,A,E	1, 2, 3
6	To understand and design oscillators	A,E	1, 2, 3
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Semiconductor Diode**		**15**	
	1.1	PN Junction, Depletion layer, Barrier potential	3	1
	1.2	Biasing- forward and reverse, Reverse breakdown, Junction capacitance and diffusion capacitance	3	1
	1.3	PN Junction diode – V-I characteristics	3	2
	1.4	Diode current equation, Diode parameters, Ideal diode	3	2
	1.5	Zener diode and its reverse characteristics. Zener diode voltage regulator.	3	2
2	**Rectification and transistor characteristics**		**15**	
	2.1	Rectification - Half wave, Full wave- Centre tapped, Bridge rectifier circuits - Nature of rectified output, Efficiency & Ripple factor.	3	3
	2.2	Filter circuits – Inductor Filter, Capacitor Filter.	3	3
	2.3	Bipolar junction transistors, Transistor biasing, characteristics of CB and CE configurations- active, saturation and cut-off regions.	3	4

	2.4	Current gains α and β. Relations between α and β.	3	4
	2.5	DC operating point, AC and DC Load line, Q-Point.	3	4
3	**Amplifiers and Oscillators**		**15**	
	3.1	Principles of feedback-positive & negative feedback, Advantages of negative feedback,	3	5
	3.2	Negative feedback circuits, Voltage series & shunt, Current series & shunt.	3	5
	3.3	Voltage Divider Bias Circuit for CE Amplifier	2	5
	3.4	Input & output Impedance. Current, Voltage and Power gains	3	5
	3.5	Oscillators -Basic ideas of oscillators. Colpitts Oscillator, Hartley Oscillator.	4	6
4	**Practicals**		**30**	
	1	Diode Characteristics - Study of dynamic and static characteristics of a Diode		1
	2	Zener Diode Characteristics- – Study of dynamic and static characteristics of a Zener diode in Reverse bias.		2
	3	Voltage regulator using Zener diode – Study of line and load regulations		2
	4	Half wave rectifier – Study of ripple factor and load regulation with and without filter circuit		2
	5	Full wave rectifier – (center tap) – Study of ripple factor and load regulation with and without filter circuit		2
	6	Full wave rectifier – (bridge) – Study of ripple factor and load regulation with and without filter circuit		3
	7	Clippers – positive, negative and biased – Study of output waveforms		3

	8	Clampers – positive, negative and biased – Study of output waveforms		3
	9	Voltage multipliers – doubler & tripler		2
	10	Common Emitter amplifier -study the amplification		5
	11	Oscillators – To construct Colpitts / Hartley's oscillator and study the waveform.		6
	12	PSpice simulation of any four experiments		6
5	**Teacher specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, Demonstration, Tutorial, Simulations, Practical
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 marks** **Formative assessment** ● Quiz ● Assignment ● Seminar **Summative assessment** ● Written test **Practical: 15 marks** ● Lab involvement ● Viva
	B. End Semester Examination **Theory: 50 marks, duration 1.5 hrs** ● Short answer type questions: Answer any 7 questions out of 10(7*2=14) ● Short essay-type questions: Answer any 4 questions out of 6(4*6=24) ● Essay type questions: Answer any 1 question out of 2(1*12=12)

	Practical: 35 marks, duration 2 hrs ● Lab Exam:30 marks ● Record: 5 marks

Textbooks

1. Theraja, B. L. Basic Electronics: Solid State. S. Chand Publishing, 2007.
2. Muhammad H. Rashid Introduction to PSpice Using OrCAD for Circuits and Electronics Pearson 3rd edition 2003.

References

1. Dennis L Eggleston Basic Electronics for Scientists and Engineers Cambridge University Press; Illustrated edition 2011.
2. Malvino, Bates, Electronic Principles McGraw Hill Education; 7th edition 2017.
3. Mehta, V. K., R. Mehta. "Principles of Electronics S. Chand & Co. Ltd., India 2005.
4. Floyd, Thomas L., David Buchla. Fundamentals of analog circuits. Pearson, 2002.
5. Boylestad, Robert L., Louis Nashelsky. Electronic devices and circuit theory. Pearson Education India, 2009.
6. Maheshwari, L.K., Anand, M.M.S. Laboratory experiments and Pspice simulations Prentice Hall India Learning Private Limited 2006.

St Thomas College Palai Autonomous

Programme	**BSc (Hons) Physics**					
Course Name	**Computational Physics- C++ Programming**					
Type of Course	**DSE**					
Course Code	**24U3PHYDSE201**					
Course Level	**200**					
Course Summary	To enable the student to master the C++ basics, understand the C++ programming tool and apply it to write moderately difficult programs and to debug for logical and syntax errors.					
Semester	3	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	1	0	75
Pre-requisites, if any	Nil					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	To define the fundamental C++ syntax, including variables, data types, and basic operators.	U	1, 3
2	To discuss the key control flow structures in C++ such as if statements, loops, and functions.	U	1, 3
3	To explain the concept of object-oriented programming and basic principles of classes and objects in C++	U	1, 3

4	To develop and implement C++ programs to solve simple computational problems using appropriate data structures and control flow	A, An, C	1, 2, 3
5	To debug the logical errors and syntax problems.	S, An	1, 2, 3
5	To develop simple to moderately complex C++ programs	S, C	1, 2, 3
6	To implement C++ programming basics to physical problems	A, C	1, 2, 3
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	**Units**	**Course description**	**Hrs**	**CO No.**
1	**Basic concepts of C++ programming**		**15**	
	1.1	Basic concepts of programming. Language classification. Steps in developing a program, Algorithm, and flowchart	3	1
	1.2	C++ language basics: C++ character set, keywords, Data types, constants, variables, declarations	3	1
	1.3	Input and output operators/functions, compound statements, arithmetic operators, unary operators, relational and logical operators, assignment operators, increment and decrement operators, and conditional operators.	3	1, 2
	1.4	Decision making and Branching: If statement, if else statement, nested if...else, statement, Else if ladder, switch statements	3	1, 2
	1.5	looping - for loop, while loop, do..while, statements, nested loop structure, break, continue and go to statements, scope of variables.	3	1, 2
2	**Arrays Classes and Objects**		**15**	
	2.1	Arrays one dimensional and two dimensional arrays, initializing, reading, writing,	7	1, 2

	2.2	User defined functions, Elements of functions, different arguments, Return values and their types, Function declaration, Function calls, different types/category of functions.	8	1, 2
3	**Classes and Objects**		**15**	
	3.1	Specifying a class- Defining member functions- nesting of member functions – private	3	3
	3.2	Member functions – arrays within a class – Memory allocation for object- static data	4	3
	3.3	Members – static member functions – arrays of objects – friendly functions.	4	3
	3.4	Operator overloading- Defining operator overloading- Overloading unary and binary -Pointers – Polymorphisms. File handling in C++ – fstream, open, fclose, fread, fwrite, etc.	4	3
4	**Practicals**		**30**	
	1	Solving a quadratic equation		4, 5, 6, 7
	2	Conversion of a decimal number into a binary number		4, 5, 6, 7
	3	Sorting an array of 10 numbers in ascending and descending order		4, 5, 6, 7
	4	Adding of two matrices		4, 5, 6, 7
	5	Generate n prime numbers		4, 5, 6, 7
	6	Find the value of sin(x), cos(x) and exp(x) using series expansion and compare it with the value obtained using math.h, tabulate the error with the number of terms in the series expansion.		4, 5, 6, 7
	7	Multiplication of two matrices		4, 5, 6, 7

	8	Create a user defined data type complex and define the necessary functions and operators using function overloading and operator overloading		4, 5, 6, 7
	9	Create a user defined datatype vector and define the necessary functions and operators using function overloading and operator overloading		4, 5, 6, 7
	10	Find out the determinant of a given matrix		4, 5, 6, 7

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Hands-on training, Presentations, Discussions
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 marks** **Formative assessment** ● Quiz ● Assignment ● Seminar **Summative assessment** ● Written test **Practical: 15 marks** ● Lab involvement ● Viva
	B. End Semester Examination **Theory: 50 marks, duration 1.5 hrs** ● Short answer type questions: Answer any 7 questions out of 10(7*2=14) ● Short essay-type questions: Answer any 4 questions out of 6(4*6=24) ● Essay type questions: Answer any 1 question out of 2(1*12=12) **Practical:35 marks, duration 2 hrs**

	• Lab Exam:30 marks • Record: 5 marks

Textbook

1. Balagurusamy, E. "Object oriented programming with C++." McGrawhill 8th Edition 2020.

Reference

1. Lafore, Robert. Object-oriented programming in Turbo C++. Galgotia publications, 2001.

St Thomas College Palai Autonomous

Programme	**BSc (Hons) Physics**					
Course Name	**Introduction to Space Physics**					
Type of Course	**DSE**					
Course Code	**24U3PHYDSE202**					
Course Level	**200**					
Course Summary	The course on Introduction to Space Physics provides a comprehensive overview of the physics governing our solar system and beyond. It explores the dynamics of solar plasmas, the structure of the heliosphere, the complexities of Earth's ionosphere, and the interaction of planetary magnetospheres with the solar wind. The implications of solar-terrestrial phenomena for space weather forecasting and understanding geophysical effects is also introduced qualitatively. Through theoretical principles and practical applications, students gain insights into the fundamental processes shaping our cosmic environment.					
Semester	**3**	Credits			**4**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	**0**	**1**	**0**	**75**
Pre-requisites, if any	Nil					

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	To gain a basic knowledge of the fundamental concepts in space physics	K, U	1
2	Comprehend the structure and dynamics of the Sun, including its atmosphere, interactions between the solar wind and solar activity.	K,U	1

3	Understand the physics of magnetospheres and ionospheres	K, U	1
4	Apply space physics principles to analyze and interpret observational data related to solar	A, An, E	2,3,4
5	Develop practical skills in data analysis and experimentation	S	6
6	Cultivate curiosity and interest in space science and exploration	I, Ap	7,8

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for transactions (Units)

Module	Unit	Course Description	Hrs	CO No.
1	**Introduction to Space Physics**		**10**	
	1.1	Overview of space physics and its significance	2	1,6
	1.2	Historical development and milestones in space physics.	2	1,6
	1.3	Basic concepts: plasma, electromagnetic fields, particles	3	1,6
	1.4	Methods of space exploration and observation	3	1,6
2	**Solar Physics and Solar Wind**		**17**	
,	2.1	Structure and dynamics of the Sun; Solar atmosphere: photosphere, chromosphere, corona	4	2,4,5
	2.2	Solar activity: sunspots, solar flares, coronal mass ejections; Solar wind: properties, origin, and effects on the solar system	5	2,4,5
	2.3	Introduction to space weather phenomena; Impacts of space weather on technology and society; Space Weather Models and Forecasting.	4	2

	2.4	A brief introduction to solar missions like Adithya L1, Parker Solar Probe, NASA's Solar Dynamics Observatory (SDO), Solar & Heliospheric Observatory (SOHO) etc.	4	2,4
3	**Magnetospheres and Ionosphere**		**18**	
	3.1	Introduction to magnetospheres; magnetic fields; Interplanetary Magnetic Field (IMF)	4	3
	3.2	Earth's magnetosphere: structure, dynamics, and magnetospheric processes; Comparison of the magnetospheres of other planets like Jupiter, Saturn, etc.	4	3
	3.3	Planetary atmospheres: composition, dynamics, and interactions with the solar wind	2	3
	3.4	Formation of the ionosphere; Ionosphere of the Earth	4	3,4,5
	3.5	Basics of Ionosonde; Measurement of total electron content measurement from GPS data	4	3,4,5
4	**Practical**		30	
	1	Analyze the SUN at different wavelengths from satellite data (https://suntoday.lmsal.com/; https://solarmonitor.org/) for a certain period and note down the various events.		2,4,5 ,6
	2	Observe and track sun spot using daily images of sunspots from satellite data (soho.nascom.nasa.gov)		2,4,5 ,6
	3	Create time-series plots showing the number of sunspots over days, months, or years. Students may be encouraged to use different in-situ and satellite data sources.		2,4,5 ,6
	4	Calculate mean, median, and standard deviation of sunspot numbers for different periods.		2,4,5 ,6
	5	Identify and analyze solar cycles		2,4,5 ,6
	6	Analyze the variations of the Interplanetary Magnetic Field (IMF, https://omniweb.gsfc.nasa.gov/form/dx1.html) over a period of time.		3,4,5 ,6
	7	Analyze the variations of the various components of Interplanetary Magnetic Field (IMF) over a period of time and estimate basic		3,4,5 ,6

		statistics for each component.		
	8	Study the correlation between IMF variations and geomagnetic activity indices like the Kp index.		3,4,5 ,6
	9	Study the behaviour of the IMF during major solar storm events.		3,4,5 ,6
	10	Analyse the diurnal variations of Total Electron Content (TEC, https://impc.dlr.de/products/total-electron-content/near-real-time-tec/near-real-time-tec-maps-global#panel-53-1) over Indian region		3,4,5 ,6
	11	Analyse the seasonal variations of Total Electron Content (TEC, https://impc.dlr.de/products/total-electron-content/near-real-time-tec/near-real-time-tec-maps-global#panel-53-1) over the Indian region.		3,4,5 ,6
	12	Analyze the Solar Index (F 10.7) and classify the solar activity over a period of time.		2,4,5 ,6
	13	Analyze the “ap” Index (nT) and classify the geomagnetic activity over a period of time.		3,4,5 ,6
	14	Analyze solar synoptic map (https://www.swpc.noaa.gov/products/solar-synoptic-map) and assess the conditions on the sun		2,4,5 ,6
	15	Plot the butterfly diagram of sunspots for any given period.		2,5,6
5	**Teacher specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Tutorials, Seminars/ Presentations, Activities, Practical sessions
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Formative assessment** **Theory: 25 marks** ● Quiz ● Two Assignments ● Seminar **Summative assessment**

	● Written tests **Practical: 15 marks** ● Lab involvement ● Viva
	B. End Semester Examination **Theory: 50 marks, duration 1.5 hrs** ● Short answer type questions: Answer any 7 questions out of 10(7*2=14) ● Short essay type questions: Answer any 4 questions out of 6(4*6=24) ● Essay type questions: Answer any 1 question out of 2(1*12=12) **Practical: 35 marks, duration 2 hrs** ● Problem solving skills: 30 marks ● Record: 5 marks

Textbooks

1. Introduction to Magnetospheric Physics. Margaret G. Kivelson and Christopher T. Russell (1995).
2. Introduction to Space Weather. Mark Moldwin (2023).

References

1. Space Physics An Introduction to Plasmas and Particles in the Heliosphere and Magnetospheres. May-Britt Kallenrode (1998).
2. Space Weather: Physics and Effects. Ioannis A. Daglis and Volker Bothmer (2007).
3. Physics of the Earth's Space Environment: An Introduction.Gerd Prölss (2004).
4. Physics of the Space Environment. Tamás I. Gombosi (1998).

St Thomas College Palai Autonomous

Programme	**BSc (Hons) Physics**					
Course Name	**Introduction to Optics**					
Type of Course	**DSE**					
Course Code	**24U3PHYDSE203**					
Course Level	**200**					
Course Summary	The primary goal of the course is to explore the fundamental nature of light. Key topics covered include the principles of geometrical and wave optics, as well as various optical systems.					
Semester	3	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	1	0	75
Pre-requisites, if any	Nil					

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Explain the concepts and theories of light.	U	1
2	Understand the concepts of speed, frequency and wavelength of light	U	1
3	Understand certain optical phenomenon	U, A, An	1, 2
5	Apply the basic ideas of geometric optics	U, A, An	1, 2
6	Apply the basic ideas of wave optics	U, A	1, 2

7	Analyse some basic optical systems	U, A, An	1, 2
8	To apply the concepts of optical phenomena in experiments.	U, A, S	1, 2
***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)**			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Fundamentals of Optics**		**15**	
	1.1	Light- Theories - Newton's corpuscular theory; Huygens' wave theory; Maxwell's electromagnetic theory; Planck's quantum theory; dual nature- particle & wave nature	4	1
	1.2	Speed, wavelength & frequency of light. Fermats' principle- laws of reflection & refraction at a plane surface using Fermats' principle.	3	2, 3
	1.3	Snells' law, relative and absolute refractive indices, total internal reflection and Critical angle,	3	3
	1.4	Geometrical path length & optical path length of rays.	2	3
	1.5	Concept of wavefronts & rays, concept of vergence- divergence, convergence.	3	3,4
2	**Geometric and wave optics**		**15**	
	2.1	**Introduction to Geometrical optics:** Paraxial approximation; Matrix method in paraxial optics: Translational matrix, reflection matrix, refraction matrix;	5	5
	2.2	Application: Thick and thin lens matrices, Derivation of Lens maker's formula.	3	5
	2.3	**Introduction to Wave Optics:** Wavefront and Huygens principle, reflection and refraction of plane wave at a plane surface using wave fronts	4	4,6

	2.4	Proof of laws of reflection and refraction using Huygens principle.	3	4, 6
3	**Optical systems**		**15**	
	3.1	Apertures, F-number, Numerical aperture, Depth of focus.	5	7
	3.2	Examples of Optical Systems: Telescopes, Cameras, Microscopes.	5	7
	3.3	Aberrations: Diffraction limit; Chromatic and monochromatic aberrations	5	7
4	**Practical**		**30**	
	1	Investigate the properties of lenses, such as focal length and image formation, using convex lens with various objects and screen distances.		8
	2	Investigate the properties of lenses, such as focal length and image formation, using concave lens with various objects and screen distances.		8
	3.	Demonstrate the law of reflection using mirrors and incident light rays at various angles.		8
	4.	Design and Explore the law of refraction using a tank of water and a light source.		8
	5	Perform spectroscopic analysis using a spectrometer to identify spectral lines, measure wavelengths and frequency.		8
	6	Design and Demonstration of double slit experiment to obtain the interference pattern using simple set up.		8
	7	Design and Demonstrate total internal reflection using a transparent material like acrylic or glass and a light source.		8
	8	Use a lens setup to observe and quantify different types of aberrations		8

	9	Familiarisation experiments using telescope:(one) ● Determination of focal length of objective . ● Measurement of angular sizes		8
	10	Familiarisation experiments using microscope (one) ● Measurement of diameter/length ● Thickness of any thin sheets (glass, paper etc)		8
5	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, Tutorial, Practical, Demonstration.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 marks** **Formative assessment** ● Quiz ● Assignment ● Seminar **Summative assessment** ● Written test **Practical:15 marks** ● Lab involvement ● Viva
	B. End Semester Examination **Theory: 50 marks, duration 1.5 hrs** ● Short answer type questions: Answer any 7 questions out of 10(7*2=14) ● Short essay-type questions: Answer any 4 questions out of 6(4*6=24) ● Essay type questions: Answer any 1 question out of 2(1*12=12)

	Practical: 35 marks, duration 2 hrs ● Lab Exam:30 marks ● Record: 5 marks

Textbook

1. Hecht, Eugene. *Optics, 5e*. Pearson Education India, 2002.
2. Subrahmanyam, N. *A textbook of Optics*. S. Chand Publishing, 2012.

References

1. Geometric and Physical Optics - R. S. LONGURST: Longman; 3rd edition
2. Introduction to Geometrical Optics- Milton Katz
3. Shankar R. Fundamentals of Physics II – Electromagnetism, Optics, and Quantum Mechanics: (The Open Yale Courses Series) Yale University Press 2019.
4. Ghatak, A. K. Optics 7th Edition McGraw Hill 2020.

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<table>
<tr><td>Programme</td><td colspan="6">BSc (Hons) Physics</td></tr>
<tr><td>Course Name</td><td colspan="6">Introduction to Materials Science</td></tr>
<tr><td>Type of Course</td><td colspan="6">DSE</td></tr>
<tr><td>Course Code</td><td colspan="6">24U3PHYDSE204</td></tr>
<tr><td>Course Level</td><td colspan="6">200</td></tr>
<tr><td>Course Summary</td><td colspan="6">The course is designed to enable the students to gain a comprehensive understanding about various types of chemical bonds, phase diagrams for different alloys, atomic diffusion mechanisms and procedures for heat treatment of metals.</td></tr>
<tr><td>Semester</td><td>3</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>3</td><td>0</td><td>1</td><td>0</td><td>75</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">Basic Physics and Mathematics</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Classify materials based on different types of bonding.	U	1, 3
2	Plot attractive, repulsive, and net energies versus interatomic separation for two atoms or ions.	A	1, 2, 3
3	Discuss the different imperfections in the crystals.	U	1, 3
4	Interpret the phase diagrams for alloy systems.	A	1, 2, 3
5	Gain knowledge on the basic concepts of phase transformation.	U	1, 3
6	Discuss the different physical properties of materials and different types of deformations.	U	1, 3
7	Analyse different crystal structures, planes and directions.	An	1, 3

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S),

Interest (I) and Appreciation (Ap)

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Bonding in solids and Imperfections**		**15**	
	1.1	Classification of materials, Advanced materials.	3	1
	1.2	Atomic bonding in solids, bonding forces, and energies, ionic, covalent, metallic, and secondary bonding.	3	1,2
	1.3	Crystal structures: Unit cells, Crystal systems.	2	1
	1.4	Crystallographic directions and planes, Miller indices. Crystalline and non-crystalline materials.	4	1
	1.5	Imperfections: Vacancies and self-interstitials, Impurities in solids.	3	3
2	**Phase Diagrams and Phase Transformations**		**15**	
	2.1	Phase diagrams, definitions and basic concepts	5	4
	2.2	Unary and binary phase diagrams, interpretation, Gibbs Phase rule.	5	4
	2.3	Phase Transformations– Basic Concepts and Kinetics.	5	5
3	**Deformation Behaviour**		**15**	
	3.1	Elastic, anelastic and viscoelastic behaviour.	3	6
	3.2	Plastic deformation, Ductility, Resilience, Toughness; Hardness, Slip, Twinning, Brittle fracture, Creep, Fatigue. (basic idea only)	7	6
	3.2	Factors affecting fatigue, Corrosion, Oxidation, and degradation	5	6
4	**Practical**		**30**	7
	1.	Estimation of Miller Indices from given XRD data.		

	2.	Sketch the Miller indices of all sides of a cube		
	3.	Determination of lattice constants of a simple cube from the given XRD data.		
	4.	Construct a Simple Cubic unit cell with a specific direction and plane within it.		
	5.	Construct an Orthorombhic unit cell with a specific direction and plane within it.		
	6.	Construct a Monoclinic unit cell with a specific direction and plane within it.		
	7.	Interpretation of a given phase diagram.		
	8.	Estimation of modulus of elasticity of a given metal/alloy.		
5	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Tutorials, Seminars/ Presentations, Activities, Practical sessions
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory:25 marks** **Formative assessment** ● Quiz ● Assignment ● Seminar **Summative assessment** ● Written test **Practical:15 marks** ● Lab involvement

	● Viva
	B. Semester End Examination **Theory: 50 marks, duration 1.5 hrs** ● Short answer type questions: Answer any 7 questions out of 10(7*2=14) ● Short essay-type questions: Answer any 4 questions out of 6(4*6=24) ● Essay type questions: Answer any 1 question out of 2(1*12=12) **Practical: 35 marks, duration 2 hrs** ● Lab Exam:30 marks ● Record: 5 marks

Textbooks

1. Callister Jr, W. D., and Rethwisch D. G. Callister's materials science and engineering. John Wiley & Sons, Ninth edition, 2014.
2. Raghavan, V., Materials Science and Engineering: A first course. PHI Learning Pvt. Ltd., Sixth edition, 2015.

References

1. Ali Omar, M. Elementary solid-state physics: principles and applications. Pearson Education India, First Edition 2001.
2. McKelvey John Philip, Solid State Physics for Engineering and Materials Science, Krieger Publishing Company 1993.

St Thomas College Palai Autonomous

Programme	**BSc (Hons) Physics**					
Course Name	**Foundations of Theoretical Physics**					
Type of Course	**DSE**					
Course Code	**24U3PHYDSE205**					
Course Level	**200**					
Course Summary	The course aims to prepare the learner with the fundamentals of theoretical physics. It also aims to equip the learner with essential techniques of theoretical physics.					
Semester	3	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	1	0	75
Pre-requisites, if any	Nil					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Initiate the study of differential equations	U An E	1, 2
2	Enable to analyze minimization problems	An E	1, 2
3	Initiate tensor algebra and calculus	U An	1, 2
4	Analyze problems in the frequency domain	An E C	1, 2
****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Differential equations: ordinary and partial**		**20**	
	1.1	General form of solution, First-degree first-order equations	4	1
	1.2	Higher-degree first-order equations Equations soluble for p; for x; for y; Clairaut's equation	3	1
	1.3	Partial differential equations: Wave equation, Diffusion equation, Laplace equation and Poisson equation.	2	1
	1.4	Separation of variables: the general method, Superposition of separated solutions	3	1
	1.5	**Practicum**(Problems)	8	1
2	**Calculus of variations**		**18**	
	2.1	The Euler–Lagrange equation, Special cases	3	2
	2.2	Some extensions: Several dependent variables; several independent variables; higher-order derivatives; variable end-points	4	2
	2.3	Constrained variation	4	2
	2.4	**Practicum-** Physical variational principles -Fermat's principle in optics; Hamilton's principle in mechanics	7	2
3	**Tensors**		**18**	
	3.1	Tensors: notation, Change of basis	1	3
	3.2	Cartesian tensors	2	3
	3.3	First- and zero-order Cartesian tensors, Second- and higher-order Cartesian tensors	4	3
	3.4	The algebra of tensors The quotient law	2	3
	3.5	Kronecker delta and Levi-Civita	2	3
	3.6	**Practicum-** Physical applications of tensors	7	3

4	**Fourier series and transform**		**19**	
	4.1	The Dirichlet conditions	1	4
	4.2	The Fourier coefficients, Symmetry considerations	4	4
	4.3	Discontinuous functions	2	4
	4.4	Complex series	2	4
	4.5	Parseval's theorem	2	4
	4.6	**Practicum-** Fourier transform : Uncertainty principle, Fraunhofer diffraction, the Dirac δ-function, relation of Dirac δ-function to Fourier transforms	8	4

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Tutorials, Seminars/ Presentations Activities, Practicum sessions
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Formative assessment** **Theory: 30 marks** ● Quiz ● Two Assignments ● Seminar ● Worksheets **Summative assessment** ● Written tests
	B. End Semester examination: 70 marks Written exam – 2hrs ● Short answer type questions: Answer any 7 questions out of 10(7*2=14) ● Short essay-type questions: Answer any 4 questions out of 6(4*6=24) ● Problem type questions: Answer any 4 questions out of 7(4*5=20) ● Essay type questions: Answer any 1 question out of 2(1*12=12)

Textbooks

1. Mathematical methods for physics and engineering, K. F. Riley, M. P. Hobson and S. J. Bence

References

1. Differential Equations with Applications and Historical Notes, G F Simmons
2. Classical Mechanics, H Goldstein, C Poole, J Safko
3. Mathematical Methods for Physicists, G B Arfken, H J Weber

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Programme	**BSc (Hons) Physics**					
Course Name	**Microcontroller Programming**					
Type of Course	**DSE**					
Course Code	**24U3PHYDSE205**					
Course Level	**200**					
Course Summary and Justification	The syllabus covers Python basics, Raspberry Pi fundamentals, GPIO programming, and GUI development using Tkinter. It includes topics like data types, operators, control statements, hardware setup, and practical projects such as LED control and integration of motion sensor.					
Semester	3	**Credits**			4	
Course Details	**Learning Approach**	**Lecture**	**Tutorial**	**Practical**	**Others**	**Total Hours**
		3	0	1	0	75
Pre-requisites	Basic knowledge in Electronics					

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains *	PO No:
1	Understand the basics of Python programming and Raspberry pi microcontroller board	U	2
2	Demonstrate proficiency in Control Structures in python and GPIO programming	U	1,2
3	Acquire expertise in GUI Programming with Tkinter	C	1,2, 10
4	Develop problem-solving skills and ignite creativity through hands-on projects and practical applications, employing Python for electronic systems	C	1,2, 10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Unit	Course description	Hours	CO No.
1	1.1	Fundamental of Python programming- Syntax rules and conventions in Python, Structure of a Python program	3	1
	1.2	Fundamental data types - Numerical data types, string. sequenc types: list, tuple, range.	3	1
	1.3	Arithmetic, Logical, Assignment, Comparison and bitwise operators	3	1
	1.4	Fundamental of Raspberry pi microcontroller board - Raspberry Pi models. Port layout of Raspberry pi 4 Installation and configuration of Raspberry pi 4	6	1
2	2.1	Control statements in Python: if, if-else, while loop, for loop, switch.	3	2
	2.2	Basic string operations -- Len, lower, upper, split, substrings, String slices - String formatting for number system applications, Converting strings to numerical values and vice versa	4	2
	2.3	Multimedia -Importing multimedia to python (picture and sound)	4	2
	2.4	Programming and Interfacing of GPIO: How the GPIOs work – pin numbering- Initializing I/O pins Introduction to I/O functions - Importing functions or system libraries (GPIO libraries). Digital read, Digital write functions	4	2
3	3.1	Basics of GUI programming - Overview of Tkinter	4	3
	3.2	Creating a basic Tkinter window - widgets: labels, buttons, entry widgets, check box – customizing widget properties	4	3,4
	3.3	Tkinter geometry managers: pack, grid, and place geometry manager	7	3,4
4	**Practicals-** Hardware & Software requirements for hands-on session: Raspberry pi 4, Thonni IDE			
	4.1	**Part A** 1. Program to perform basic logic operations 2. Program for toggling the bits of Port B 3. Program to find the sum of a given data set 4. Program for string operations 5. Program to find largest and smallest number in an array 6. Program to display even numbers from 1-10	20	4

	4.2	7. Program to display a string with number input **Part B** 1. Blinking LED 2. Controlling LED with a push button 3. Blinking LEDs in a pattern 4. Traffic light controller design 5. Controlling LED with motion sensor 6. Intruder Alert System using motion sensor & buzzer	10	4
5		**Teachers Specific Content**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Leverage a blended learning approach with a mix of lectures, interactive discussions, and hands-on lab sessions
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** Theory: - 25 Marks 1. Internal Test – One MCQ based and one extended answer type 2. Seminar Presentation – a real time application of emerging technology to be identified and present it as seminar Practical: 15 Marks 1. lab: A combination of quizzes, assignments 2. Performance 3. Case Study **B. End Semester examination** 1. Written Test (50 marks)**, duration 1.5 hrs** a. MCQ - 10 Marks b. Short answer questions (4 out of 6 questions)-4x5=20 marks c. Essay questions -2 out of 4 - 2x10=20 marks 2. Practical Exam (35 marks)**, duration 2 hrs** a. Viva b. Lab report c. Demonstration

Textbooks

1. Lambert, Kenneth A. Fundamentals of Python: first programs. Cengage Learning, 2018.
2. Summerfield, Mark. Programming in Python 3: a complete introduction to the Python language. Addison-Wesley Professional, 2010.

References

1. Charles Dierbach, “Introduction to Computer Science using Python”, Wiley, 2015
2. R Nageswara Rao, Python Programming

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<table>
<tr><td>Programme</td><td colspan="6">BSc (Hons) Physics</td></tr>
<tr><td>Course Name</td><td colspan="6">Properties of Matter</td></tr>
<tr><td>Type of Course</td><td colspan="6">DSE</td></tr>
<tr><td>Course Code</td><td colspan="6">24U3PHYDSE207</td></tr>
<tr><td>Course Level</td><td colspan="6">200</td></tr>
<tr><td>Course Summary</td><td colspan="6">The course on Properties of Matter is designed to develop a comprehensive understanding of the behaviour of materials to external forces. In addition, the student will explore key concepts related to fluid dynamics covering surface tension, capillary rise, viscosity, and buoyancy as well as waves and their varied applications.</td></tr>
<tr><td>Semester</td><td>3</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>3</td><td>0</td><td>1</td><td>0</td><td>75</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">Nil</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	To gain a basic knowledge on elasticity principles including Hooke's Law, elastic moduli	U	1
2	To predict the behaviour of materials under different stress and strain conditions	A	1, 2
3	To illustrate the dynamics of fluids, with a focus on surface tension,	U, A, An	1, 2

	capillary rise, viscosity.		
4	To gain a thorough understanding of wave motion, including the properties of amplitude, wavelength, frequency, and wave speed	U	1
5	To analyse the different characteristics of mechanical waves and electromagnetic waves.	U, An	1, 2
6	To discuss the interdisciplinary nature of waves and their significance in applications ranging from communication technologies to medical imaging.	U	1, 2
7	To get hands on expertise in solving different physical problems by applying the theoretical concepts in properties of matter	A, E	1, 2, 3
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Transactions (Units)

Module	**Unit**	**Course Description**	**Hrs**	**CO No.**
1	**Elasticity**		**13**	
	1.1	Elastic behaviour of solids; Types of elasticity, Work done per unit volume in a strain, stress-strain diagram, Poisson's ratio, limiting values, Elastomers	4	1, 2
	1.2	Twisting couple, torsion pendulum, determination of moment of inertia.	2	1, 2
	1.3	Bending of beams, bending moment, Cantilever (when weight is ineffective);	2	1, 2
	1.4	Distinction between uniform and non-uniform bending, I shape girders	3	1, 2
	1.5	Piezoelectricity, piezoelectric sensors, and its applications	2	1, 2

2	**Surface tension and Viscosity**		**16**	
	2.1	Molecular force– molecular range-sphere of influence-theory of surface tension, surface film and surface energy, applications surface tension and capillary effect, factors affecting surface tension	3	3
	2.2	Excess pressure over curved surface – application to spherical and cylindrical drops and bubbles, force between two plates separated by a thin layer of liquid	3	3
,	2.3	Classification of Fluid Flow, Viscosity: Coefficient of viscosity, Factors affecting viscosity, Reynold's number	3	3
	2.4	Poiseuille's formula – Correction to Poiseuille's formula	2	3
	2.5	Equation of continuity, Bernoulli's theorem, - Applications; Euler equation, Terminal velocity,	3	3
	2.6	Stoke's law	2	3
3	**Waves and Acoustics**		**16**	
	3.1	Wave Motion, Equation of a plane progressive wave, Differential equation of a one-dimensional wave, distinction between progressive and stationary wave, Types of waves, Transverse and Longitudinal waves.	5	4, 5
	3.2	Superposition of waves and Beats, Speed of sound and Mach number	5	4, 6
	3.3	Ultrasonics - properties, production by Piezoelectric effect and magnetostriction method	2	4, 6
	3.4	Ultrasonics - Detection, properties, and applications-ultrasound Imaging	2	4, 6
	3.5	Doppler Effect, SONAR	2	4, 6
4	**Practicals**		**30**	
	1	Determination of Poisson's ratio of rubber.		7
	2	Determination of rigidity modulus- Static torsion method.		7

	3	Determination of rigidity modulus- Torsion pendulum-identical masses.		7
	4	Measurement of Young's modulus of a metallic scale-Cantilever oscillations.		7
	5	Effect of impurities on surface tension- capillary rise method.		7
	6	Variation of viscosity with temperature.		7
	7	Verification of Bernoulli's theorem		7
	8	Coefficient of viscosity by Stoke's method		7
	9	Determination of velocity of ultrasonic waves in a liquid.		7
	10	Sonometer – Determination of frequency of given tuning fork, unknown mass, and verification of laws of strings.		7
	11	Create an animation of the wave ($Asinkx - \omega t$) (using Python). Select values for amplitude(A), wave number (k), angular frequency (ω), and define ranges for both x and t. After successfully animating this wave, extend the animation to include the wave ($Asinkx - \omega t$)+ ($Asinkx + \omega t$)		7
	12	Implement a (python) program that models the deformation of the material under an applied load and generates a plot of the stress-strain relationship.		7
5	**Teacher specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Tutorials, Seminars/ Presentations, Activities, Practical sessions
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)**

	Theory: 25 marks **Formative assessment** ● Quiz ● Assignment ● Seminar **Summative assessment** ● Written test **Practical:15 marks** ● Lab involvement ● Viva
	B. End Semester Examination **Theory: 50 marks, duration 1.5 hrs** ● Short answer type questions: Answer any 7 questions out of 10(7*2=14) ● Short essay-type questions: Answer any 4 questions out of 6(4*6=24) ● Essay type questions: Answer any 1 question out of 2(1*12=12) **Practical: 35 marks, duration 2 hrs** ● Lab Exam:30 marks ● Record: 5 marks

Textbooks

1. Mathur D. S., Mechanics. S. Chand Publishing, 2000.
2. Mathur D. S., Elements of Properties of matter, 2014, S.Chand and Co
3. Murugeshan, R., Sivaprasath K. Properties of matter and Acoustics S Chand 2005.

References

1. Shankar R. Fundamentals of Physics I – Mechanics, Relativity, and Thermodynamics (Open Yale Courses) Yale University Press, 2019.
2. BrijLal and Subrahmanyam N., Properties of Matter, S.Chand and Co. 2003.
3. Upadhyaya J. C., Mechanics Ram Prasad Publications 2017.
4. Butcher, Ginger. *Tour of the electromagnetic spectrum*. Government Printing Office, 2016.

St Thomas College Palai Autonomous

Programme						
Course Name	**Atomic and Molecular Spectroscopy**					
Type of Course	**DSC B**					
Course Code	**24U3PHYDSC202**					
Course Level	**200**					
Course Summary	This course provides a comprehensive exploration of the principles, techniques, and applications of Atomic and Molecular Spectroscopy					
Semester	3	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	1	0	75
Pre-requisite, if any	Basic concepts of Atomic structure and Electronic Transitions					

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains***	**PO No**
1	To gain knowledge on different models of atom and the foundations of Atomic Spectroscopy	U	1, 2
2	To describe the significance of understanding Electromagnetic Spectrum and the basic concepts involved in Molecular Spectroscopy	K, U	1, 2
3	To discuss the principles of Resonance Spectroscopy and its applications	U	1, 2
4	To acquire hands on expertise in using different soft wares for the analysis of Molecular Spectra	U, A	1, 2
5	To analyse spectrum of different samples and explain the results	U, A, An	1, 2
6	To make use of the Spectrometer and optical elements for interpreting the spectrum of different light sources	U, A, An	1, 2

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Atomic Physics**		**16**	
	1.1	Electromagnetic spectrum. Hydrogen spectrum. Bohr atom model –quantum condition and frequency condition-limitations of the model.	3	1
	1.2	Orbital angular momentum and spin angular momentum. Orbital magnetic moment and spin magnetic moment, gyromagnetic ratio, the energy of magnetic moment in a magnetic field.	3	1
	1.3	Vector Atom Model-quantum numbers and term symbols. Spin-orbit interaction -fine structure-fine structure of sodium D lines.	3	1
	1.4	L-S and j-j couplings.	2	1
	1.5	Normal Zeeman effect -experimental arrangement. Anomalous Zeeman effect -Lande g-factor. Paschen-Back effect.	5	1
2	**Molecular Spectroscopy**		**16**	
	2.1	Types of Molecular energies, classification of molecules, rotational spectra of rigid diatomic molecules	4	2
	2.2	Infrared spectroscopy- vibrational energy of a diatomic molecule for harmonic vibrations-vibrational spectrum.	4	2
	2.3	Raman Scattering- Quantum theory of Raman Effect, Stokes and anti- stokes lines, Mutual exclusion of IR and Raman spectra	4	2
	2.4	Electronic transitions- UV and Visible spectra Fluorescence and Phosphorescence	4	2

3	**Resonance Spectroscopy and Activities**		**13**	
	3.1	NMR Spectroscopy- Basic principles, resonance condition,	4	3
	3.2	ESR Spectroscopy- Basic principles	4	3
	3.3	Activity 1. GAMESS/ Gaussview softwares- (a) View molecular vibrations (b) Demonstration of IR, Raman, UV spectra 2. Basic analysis of the spectrum of samples 3. Identify the spectrometers employed in Chandrayaan missions	5	4, 5
4	**Practicals**		**30**	
	1	Verification of Beer-Lambert law-dependence of concentration/path length		6
	2	Determination of refractive index of material of prism using spectrometer.		6
	3	Dispersive power of prism using Spectrometer.		6
	4	Dispersive power of grating using Spectrometer.		6
	5	Using a (Quantum chemical) computational software, obtain the vibrational frequencies, bond length, bond angle, dipole moment & Total energy of H2O and CO2 molecules		4
	6	Using a (Quantum chemical) computational software compare the IR and Raman spectra of H2O and CO2 molecules		4
	7	Determination of Planck's constant using LED.		6
	8	Study the V-I characteristics of LEDs emitting different wavelengths and compare their turn-on voltages		6
	9	Determination of wavelength of a laser using diffraction grating		6
	10	Analysis of FTIR/Raman spectrum from given data.		6

5	**Teacher specific content**	

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Tutorials, Seminars/ Presentations, Activities, Practical sessions.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 marks** **Formative assessment** ● Quiz ● Assignment ● Seminar **Summative assessment** ● Written test **Practical: 15 marks** ● Lab involvement ● Viva
	B. Semester End Examination **Theory: 50 marks, duration 1.5 hrs** ● Short answer type questions: Answer any 7 questions out of 10 (7*2=14) ● Short essay-type questions: Answer any 4 questions out of 6(4*6=24) ● Essay type questions: Answer any 1 question out of 2(1*12=12) **Practical: 35 marks, duration 2 hrs** ● Lab Exam:30 marks ● Record: 5 marks

Textbook

1. Aruldhas, G. Rajagopal P. Modern Physics, Prentice- Hall of India 1st Edition 2005

References

1. Beiser, Arthur, Mahajan. Shobhit, Choudhury, S. Rai. Concepts of modern physics. McGraw Hill Education, 2017 7th Edition
2. Banwell C.N., McCash E. M. Fundamentals of Molecular Spectroscopy-4th Edition, McGraw Hill 2017.
3. The Feynman Lectures on Physics, Volume III https://www.feynmanlectures.caltech.edu/III_toc.html
4. G Aruldhas, Molecular Structure and Spectroscopy, Prentice- Hall of India

St Thomas College Palai Autonomous

Programme						
Course Name	**Renewable Energy Sources**					
Type of Course	**MDC**					
Course Code	**24U3PHYMDC200**					
Course Level	**200**					
Course Summary	This course is intended to provide the students with the global energy scenario in the 21st century and the significance of renewable energy sources as an alternative for the other existing energy sources. Exploring the diverse facets of energy, this course provides insights into the global and national energy scenarios, emphasizing sustainability principles. It focuses on renewable energy sources such as solar, wind, ocean, hydro, biomass, and hydrogen, detailing their principles, applications, and environmental implications. Additionally, the course delves into safety measures and effective management practices within the realm of alternative energy, offering a comprehensive understanding of the evolving energy landscape.					
Semester	3	Credits			3	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	0	0	45
Pre-requisites, if any	Nil					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains*	PO No
1	Understands the global energy scenario.	U	1,2
2	Understand the significance of solar energy-storage and applications	U	1,2

3	Discuss the principle and working of wind, Ocean and Hydroelectric power systems.	U	1,2
4	Gain knowledge about Biomass conversion technologies	U, An	1,2
5	Understand Biogas generation	U	1,2
6	Identify the role of Hydrogen as an alternative fuel	U	1,2
7	Gain hands on expertise in the novel Energy efficient methods and techniques	A, An	1,2
***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)**			

COURSE CONTENT

Content for Classroom Transaction (Units)

Module	**Units**	**Course description**	**Hrs**	**CO No.**
1	**1.1 Energy Scenario**		**5**	
	1.1.1	Energy Scenario – Global and National, Energy and sustainable development, Global and Indian Scenario	2	1
	1.1.2	Principles of Renewable energy, Sources of Renewable energy – an overview, Environmental and Social Implications	3	1
	1. 2 Solar Energy		**17**	
	1.2.1	Solar Energy -Introduction and Significance, Solar Thermal Energy – (Concentrator, Non-Concentrator)	3	2
	1.2.2	Solar PV systems – Principle and characteristics, Storage of solar energy, Types of Solar Cells. Installation and Maintenance of Solar PV systems.	7	2
	1.2.3	Applications – Solar Pond, Solar Cooker, Solar Water	7	2

		Heater, Solar Dryer, Desalination, Solar Power Plant.		
2	**Wind, Ocean and Hydro Energy**		**15**	
	2.1	Wind, Ocean and Hydro Energy: Wind power systems – Principle and Working, Wind turbines – types	5	3
	2.2	Ocean Energy Harvesting – Principle and Working, Types of Ocean Energy: Wave, OTEC and Tidal Energy	5	3
	2.3	Hydroelectric Power Systems – Principle and Working	5	3
3	**Biomass and Hydrogen Energy**		**8**	
	3.1	Biomass and Hydrogen Energy: Biomass Conversion Technologies: Dry and Wet Processes	2	4
	3.2	Biogas Generation: Fixed Dome Type and Moving Drum type	2	5
	3.3	Hydrogen – Production and Storage, Hydrogen as Alternative Fuel for Automobiles, Safety and Management	4	6
	Activity			
	1	Demonstration of Training modules on Solar energy.		7
	2	Demonstration of Training modules on wind energy.		7
	3	Solar PV systems – Installation and Maintenance - HoT.		7
	4	Solar Energy Harvesting – Estimation of Efficiency and Fill Factor		7

	5	Conversion of thermal energy into voltage (using thermoelectric modules)		7
	6	Hydro energy – Energy Conversion		7
	7	Biofuels – Energy Conversion		7
	8	Energy Audit at your home/college/village		7
	9	Industrial Visit to Renewable energy power Plant		7
	10	Create a wind map of the institute and identify locations with the highest wind speeds.		7
	11	Set up small-scale biogas plant using plastic bottles or containers, and observe the gas production over a period		7
	12	Creating posters to raise awareness about the importance of solar energy.		7
	13	Create a flow chart detailing the steps involved in the generation of hydroelectric power		7
	14	Collect images from magazines or draw pictures to represent biomass materials, conversion processes, and end-use applications.		7
	15	Design and build a solar cooker using materials like cardboard, aluminium foil, and glass		7
4	**Teacher specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, Group Discussion, Activities
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)**

	Theory: 25 marks **Formative assessment** ● Quiz ● Assignments ● Seminar **Summative assessment** ● MCQ Exams
	B. Semester End examination (Theory based Examination) **Total: 50 marks, duration 1.5 hrs** Multiple Choice Questions (25*2=50)

Textbooks

1. Twidell, John. Renewable energy resources. Routledge, 4th Edition, 2021.
2. Rai G.D., non-conventional energy sources, Khanna Publishers, 1988.
3. Boyle Godfrey (Editor), Renewable Energy, Power for a sustainable future, Oxford University Press, 3rd Edition 2012.

St Thomas College Palai Autonomous

Programme	**BSc (Hons) Physics**					
Course Name	**Science and Society**					
Type of Course	**VAC**					
Course Code	**24U3PHYVAC200**					
Course Level	**200**					
Course Summary	This course is meant for students of the humanities/commerce streams, to provide an overview of the nature of S&T and its impact on society. It will also provide a broad introduction to the most significant discoveries and inventions of modern science that have changed our lives and to bring into focus the need for developing a critical appraisal of the issues related to the connection of S&T with society. This course will help to develop scientific temper among the students.					
Semester	**3**	Credits			**3**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	**0**	**0**	**0**	**45**
Pre-requisite, if any	Nil					

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	To introduce the concepts and practice of Scientific methods with a historical outline	U	1,2
2	To discuss the impact of Modern Science & technology in the Society	U	1

3	To address the Ethical issues related to the practice of Modern Technology	An	2, 8, 10
4	To point out the need of practicing Scientific temper in daily life	U, An	1, 2,10
5	To critically evaluate the distinction between myth and fact in Science by using case studies	E	1, 2, 10
6	To evaluate the errors involved in the measurements	A, E	1, 2
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module	**Units**	**Course description**	**Hrs**	**CO No.**
1	**1.1 Science and Scientific methods**		**8**	
	1.1.1	What is Science? A discussion on Hypothesis, Theories, Laws and Experimentation in Science	2	1
	1.1.2	Verification of theories (Proving) Corroboration and falsification (Disproving)	2	1
	1.1.3	Revision of Scientific theories and laws	2	1
	1.1.4	Open ended nature of the scientific quest	2	1
	1.2 Historic Perspectives of Universe		**8**	
	1.2.1	Concept of flat earth and round earth: Measurement of earth by Eratosthenes and Aristarchus	2	1
	1.2.2	Geocentric model: Earth is the centre -Ptolemy, Aristotle	2	1
	1.2.3	Heliocentric model: Sun is the centre –Copernicus	2	1
	1.2.4	Galileo, his Experiments and Observations	2	1
2	**Modern Science and Technology (terminology)**			

	2.1	1. Optics and Photonics	**10**	2
		2. Nanotechnology		
		3. Space Science,		
		4. Antibiotics and Vaccination		
		5. Atomic Energy		
		6. Semiconductor Revolution and Telecommunication		
		7.Artificial Intelligence and Data science		
		8. Quantum computing		
	2.2	Ethical issues related to science and technology.	4	2, 3
3	**3.1: Need for Scientific Temper**		**2**	
	3.1.1	Need for an informed public about Science and Technology		4
	3.1.2	Scientific temper in Indian Constitution & Science Policy in India		4
	3.2: Myths Versus Facts		**8**	
	3.2.1	Astronomy and Astrophysics		5
	3.2.2	Eclipse, Origin of Universe		5
	3.2.3	Nuclear Radiation -		5
	3.2.4	Theory of Evolution		5
	3.3: Addressing Misconceptions in Error Analysis		**5**	
	3.3.1	Basic ideas of uncertainty in measurements		6
	3.3.2	Random and systematic errors		6

	3.3.3	Rejection of Spurious measurements		6
4	**Teacher Specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, Demonstration, Field Trip, Observation and interactive Session, Group discussion.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 marks** **Formative assessment** ● Quiz ● Assignments ● Seminar **Summative assessment** ● MCQ Exams
	B. Semester End examination (Theory based Examination) **Total: 50 marks, duration 1.5 hrs** Multiple Choice Questions (25*2=50)

Textbooks

1. Russell, Bertrand. The impact of science on society. Routledge, 2016.
2. Bala, Arun, The Dialogue of Civilizations in the Birth of Modern Science, New York, NY: Macmillan 2008.

References

1. Abd-El-Khalick, Fouad. Developing deeper understandings of nature of science: The impact of a philosophy of science course on preservice science teachers' views and instructional planning." *International Journal of Science education* 27.1 2005
2. Basu Biman and Khan Hasan Jawad, Marching Ahead with Science, National Book Trust, 2001.
3. Gopalakrishnan (2006). Inventors who revolutionised our Lives. National Book Trust
4. Stanford Encyclopedia of Philosophy: Helen Longino's "The Social Dimensions of scientific knowledge"

   www.http://plato.stanford.edu/entries/scientific-knowledge-social/

SEMESTER 4

St Thomas College Palai Autonomous

Programme	**BSc (Hons) Physics**					
Course Name	**Wave Optics**					
Type of Course	**DSC**					
Course Code	**24U4PHYDSC200**					
Course Level	**200**					
Course Summary	The main objective of the course is to understand the wave nature of light. The key points related to wave nature of light discussed in this course are interference, Huygens principle, Fresnel and Fraunhofer diffraction, basic ideas and application of polarisation.					
Semester	4	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	**0**	**1**	**0**	**75**
Pre-requisites, if any	Nil					

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Describe the concept of waves, characteristics and its mathematical representations	U	1
2	Explain the phenomenon of polarisation of light	U	1
3	To distinguish different types of polarisation using the concepts of	U, A, An	1, 2

	polarisation		
4	Relate superposition principle and interference of light	U, A	1, 2
5	Determine interference patterns in specific cases	U, A, An	1, 2
6	Compare the Fresnel and Fraunhofer Diffraction using wave theory	U, A	1, 2
7	Relate the ideas of Fraunhofer diffraction in different conditions	U, A, An	1, 2
8	Apply the concepts of optical phenomena in experiments.	U, A, S	1, 2
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Polarization of electromagnetic Waves**		**15**	
	1.1	One dimensional waves, Harmonic Waves, Phase and Phase Velocity, Plane Waves, Three-Dimensional Differential Wave Equation, Spherical Waves and Cylindrical waves	3	1
	1.2	The Nature of Polarized Light - Linear Polarization, Circular Polarization, Elliptical Polarization	3	2, 3
	1.3	Polarizers, Malu’s Law, Dichroism, Birefringence, Birefringent Crystals - Wavefronts and Rays in Uniaxial Crystals, Birefringent Polarizers	4	2, 3
	1.4	Polarisation - Polarisation by scattering, Polarisation by absorption	2	2, 3
	1.5	Retarders - Wave plates, Half wave and Quarter wave plates, Optical Activity	3	2, 3
2	**Interference**		**15**	
	2.1	The superposition principle, Phasors and the addition of waves, Conditions for Interference	3	4
	2.2	Wavefront-Splitting Interferometers, Young’s Experiment, Fresnel’s biprism,	4	4, 5

	2.3	Amplitude-Splitting Interferometers- Inference by a plane parallel thin film, Newtons Rings, Michelson Interferometer	8	
3	**Diffraction**		**15**	
	3.1	The Huygens–Fresnel Principle, Fraunhofer and Fresnel Diffraction, Several Coherent Oscillators	3	6, 7
	3.2	Fraunhofer Diffraction-Diffraction by Single Slit, Diffraction by Double Slit, Diffraction by Many Slits, The Diffraction Grating	7	6, 7
	3.3	Fresnel Diffraction- The Free Propagation of a Spherical Wave – Fresnel half period zone, The Fresnel Zone Plate, Fresnel Diffraction by a Slit	5	6, 7
4	**Practical**		**30**	
	1	Determination of optical constants of a convex lens using Liquid Lens arrangement (water and mercury given)		8
	2	Determination of the refractive index of a liquid filled in a hollow prism using a spectrometer.		8
	3	Determination of the refractive index of the material of a small angled prism using a spectrometer.		8
	4	Determination of wavelength of monochromatic light source using Newton's rings apparatus.		8
	5	Determination of the diameter of a thin wire by forming an air wedge.		8
	6	Resolving power of grating using a spectrometer.		8
	7	Study the polarisation of the given laser beam using an analyser and verify Malus law		8
	8	To determine particle size using laser beam diffraction		8
	9	To study the diffraction pattern using a single slit and calculate slit width		8

	10	To measure the wavelength of laser light using a millimetre scale as grating		8
5	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, Tutorial, Practical, Demonstration.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 marks** **Formative assessment** ● Quiz ● Assignment ● Seminar **Summative assessment** ● Written test **Practical: 15 marks** ● Lab involvement ● Viva
	B. End Semester Examination **Theory: 50 marks, duration 1.5 hrs** ● Short answer type questions: Answer any 7 questions out of 10(7*2=14) ● Short essay-type questions: Answer any 4 questions out of 6(4*6=24) ● Essay type questions: Answer any 1 question out of 2(1*12=12) **Practical: 35 marks, duration 2 hrs** ● Lab Exam:30 marks ● Record: 5 marks

Textbook

1. Hecht, Eugene. Ganesan A. R. Optics. Pearson Education India, 2019.

References

1. Shankar R. Fundamentals of Physics II – Electromagnetism, Optics, and Quantum Mechanics: (The Open Yale Courses Series) Yale University Press 2019.
2. Ghatak, A. K. Optics 7th Edition McGraw Hill 2020.

St Thomas College Palai Autonomous

Programme	**BSc (Hons) Physics**					
Course Name	**Electromagnetic Theory**					
Type of Course	**DSC**					
Course Code	**24U4PHYDSC201**					
Course Level	**200**					
Course Summary	This course provides a comprehensive understanding of the principles governing electromagnetic fields and their applications. It explores the fundamental laws and equations that describe the behaviour of electric and magnetic fields, as well as their interactions. By the end of the course, students should have an understanding of electromagnetic theory, enabling them to analyze and solve complex problems in classical electromagnetism.					
Semester	4	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	**0**	**0**	**0**	**60**
Pre-requisites, if any	Basic knowledge of Vector Calculus.					

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains***	**PO No**
1	Explain the concept of divergence and curl of electric field.	U	1, 2
2	Determine potential and field in electrostatics	U, E	1
3	Summarise the concepts of Lorentz force, Magnetic field and Vector potential	U	1, 2
4	Make use of Ampere's law in simple cases of Magnetostatics.	U, A	1
5	Illustrate the concepts of electric field and magnetic field in matter.	U,A, E	1, 2
6	Explain electromotive force and Faraday's law	U, An	1

7	Describe the Maxwell' Equation and continuity equations	U, An	1, 2
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	**Units**	**Course description**	**Hrs**	**CO No.**
1	**Electrostatics**		**15**	
	1.1	Electrostatic field – Coulomb's law, Electric field, Continuous charge distributions.	3	1
	1.2	Divergence and curl of electrostatic field-Field lines, flux, and Gauss's law. Divergence of E, Applications of Gauss's Law, Curl of E	3	1, 2
	1.3	Electric potential, Poisson's Equation and Laplace's Equation, Potential of a localized charge distribution, Boundary Conditions.	3	1,2
	1.4	Work and energy in electrostatics- Energy of a discrete charge distribution, Energy of a continuous charge distribution.	3	2
	1.5	Conductors: basic properties, induced charges, surface charge.	3	2
2	**Magnetostatics**		**13**	
	2.1	Lorentz force law, Magnetic fields, Magnetic Forces, Currents.	4	3
	2.2	Biot -Savart law, Magnetic Field of Steady Current – Divergence of B, Straight line currents. Amperes Law.	4	3

	2.3	Applications of Ampere's law – Long straight current , Solenoid. Comparison of Magnetostatics and Electrostatics. Magnetic Vector Potential. Magnetostatic Boundary Conditions.	5	3, 4
3	**3.1 Electric field inside matter**		**18**	
	3.1.1	Dielectrics: induced dipoles; alignment of polar molecules, Polarization, The Field of a Polarized object: bound charge, physical interpretation of bound charges, The field inside a dielectric.	5	5
	3.1.2	Electric displacement, Gauss's law in the presence of dielectrics, Boundary Conditions for D – Linear Dielectrics, Susceptibility, Permittivity, Dielectric constant.	5	5
	3.2 Magnetic Fields in Matter			
	3.2.1	Diamagnets, Paramagnets and Ferromagnets. Torques and Forces on Magnetic, Dipoles, Magnetization, The Field of a Magnetised Object, Relation between M, B and H.	5	5
	3.2.2	Linear and Nonlinear Media, Magnetic susceptibility and permeability.	3	5
4	**Maxwell's equations**		**14**	
	4.1	Ohm's law, electromotive force, motional emf – Electromagnetic induction – Faraday's law, induced electric field	5	6
	4.2	Electrodynamics before Maxwell, Maxwell's modification of Ampere's law, Maxwell's equations	5	7
	4.3	Continuity equation. Wave equation for E and B in vacuum. Maxwell's equation in matter.	4	7
5	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Demonstrations, Presentations, Discussions
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 marks** **Formative assessment** ● Quiz ● Assignments ● Seminar **Summative assessment** ● Written tests
	B. End Semester Examination (Theory based Examination) **Total: 70 marks, duration 2 hrs** ● Short answer type questions: Answer any 10 questions out of 12(10*3=30) ● Short essay type questions: Answer any 4 questions out of 6(4*7=28) ● Essay type questions: Answer any 1 question out of 2(1*12=12)

Textbook

1. Griffiths, David J. Introduction to electrodynamics. Pearson Education India Learning Private Limited; 4th edition (1 January 2015)

References

1. Shankar R. Fundamentals of Physics II – Electromagnetism, Optics, and Quantum Mechanics: (The Open Yale Courses Series) Yale University Press 2019.
2. Feynman, Richard Phillips. Feynman lectures on physics: Exercises. Volume II Mir, 1967.
3. Jackson J. D. Classical Electrodynamics Wiley; Third edition 2007

St Thomas College Palai Autonomous

Programme	**BSc (Hons) Physics**					
Course Name	**Semiconductor Electronics**					
Type of Course	**DSE**					
Course Code	**24U4PHYDSE200**					
Course Level	**200**					
Course Summary	This course covers key concepts in electronics, focusing on Field Effect Transistors (FETs), Metal-Oxide-Semiconductor FETs (MOSFETs), integrated circuits (ICs), operational amplifiers (op-amps), binary numbers, logic gates, and Boolean algebra. It explores the operation, characteristics, and applications of FETs and MOSFETs, as well as IC fabrication and usage. Practical sessions involve circuit design, waveform shaping, logic gate implementation, and amplifier construction, emphasizing both theoretical understanding and hands-on experimentation.					
Semester	4	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	**0**	**1**	**0**	**75**
Pre-requisites, if any	Nil					

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	To study the characteristics and applications of JFET	U	1,2,3
2	To study the characteristics and applications of MOSFET	U	1,2,3
3	Comprehend the characteristics and differences between JFETs and Bipolar Junction Transistors, the working of depletion-type and enhancement-type MOSFETs, and the fundamentals of	U, A	1,2,3

	integrated circuits, operational amplifiers and logic gates.		
4	Utilize knowledge to perform decimal-to-binary conversions, binary arithmetic and implement logic operations using basic and universal gates. Apply op-amp configurations in practical circuits.	U, A, An	1,2,3
5	Understand Binary systems and logic gates	U	1,2,3
6	Develop hands-on skills in constructing and testing electronic circuits, verifying truth tables, and applying Boolean algebra.	A, An,S	1,2,3
7	Design and construct various circuits, including amplifiers using JFET/MOSFET, and waveform shaping circuits using op-amps	An, C, S	1,2,3
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	**Units**	**Course description**	**Hrs**	**CO No.**
1	**FET and MOSFET**		**15**	
	1.1	Field Effect Transistors- Junction Field Effect Transistor, Formation of Depletion Region in JFET – Operation of JFET	4	1
	1.2	Characteristics of JFET – Drain Characteristics, Comparison between Junction Field Effect Transistors and Bipolar Junction Transistor	4	1
	1.3	MOSFET –Working of a Depletion type MOSFET, Drain and Transfer Characteristics for Depletion Type MOSFET	4	2
	1.4	Enhancement-Type MOSFET, Drain and Transfer Characteristics of Enhancement type MOSFET	3	2
2	**Integrated Circuits**		**15**	

	2.1	Advantages and disadvantages of IC’s, Inside an IC Package, Fabrication of components on Monolithic IC, Simple Monolithic IC-IC Packings, IC Symbols-Scale of Integration-Some circuits Using IC’s	4	3
	2.2	Introduction to Op-Amps, Block diagram representation of a typical op-amps, Virtual ground and summing point	5	4
	2.3	OP-AMP Applications- Linear Amplifier Unity Follower-Adder or Summer -Subtractor, Integrator Differentiator, Comparator	6	4
3	**Binary Numbers, Logic Gates and Boolean Algebra**		**15**	
	1.1	**Binary Numbers** Decimal-to-Binary Conversion, Binary Arithmetic, Complements of Binary Numbers, Signed Numbers, Arithmetic Operations with Signed Numbers	5	5
	1.2	**Logic Gates** The Inverter, The AND Gate, The OR Gate, The NAND Gate, The NOR Gate, The Exclusive-OR and Exclusive-NOR Gates, Programmable Logic, Fixed-Function Logic Gates	6	5
	1.3	**Boolean Algebra** Boolean Operations and Expressions, Laws and Rules of Boolean Algebra, DeMorgan’s Theorems, Standard Forms of Boolean Expressions, Boolean Expressions and Truth Tables	4	6
4	**Practical**		**30**	6, 7
	4.1	Wave Shaping RC Circuits- Integrator and Differentiator		
	4.2	OPAMP- Adder and Subtractor		
	4.3	OPAMP- Square Wave Generator		
	4.4	OPAMP- Inverter, Non- inverter and Buffer		

	4.5	Realization of logic gates – AND, OR and NOT – Using diodes, transistors etc.		
	4.6	Realization of logic gates – AND, OR and NOT – Using universal gates		
	4.7	Verification of truth table of NAND, NOR, XOR and XNOR gates		
	4.8	Verification of De Morgan's theorems – Using IC 7400		
	4.9	Study the drain and transfer characteristics of JFET /MOSFET.		
	4.10	Design and construct an amplifier using JFET/MOSFET and study its frequency response.		
5	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Discussions, Demonstrations
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 marks** **Formative assessment** ● Quiz ● Assignment ● Seminar **Summative assessment** ● Written test **Practical: 15 marks** ● Lab involvement

	● Viva
	B. End Semester Examination (ESE) **Theory: 50 marks, duration 1.5 hrs** ● Short answer type questions: Answer any 7 questions out of 10(7*2=14) ● Short essay-type questions: Answer any 4 questions out of 6(4*6=24) ● Essay type questions: Answer any 1 question out of 2(1*12=12) **Practical:35 marks, duration 2 hrs** ● Lab Exam:30 marks ● Record: 5 marks

Textbook

1. Basic Electronics – Solid State, B.L. Theraja-S Chand (2005)
2. A Text Book of Applied Electronics- R.S.Sedha

References

1. Principles of electronics, VK Mehta, S Chand
2. Basic Electronics(7thEdition), Malvino and Bates, TMH

St Thomas College Palai Autonomous

Programme	**BSc (Hons) Physics**					
Course Name	**Numerical Methods for Computational Physics**					
Type of Course	**DSE**					
Course Code	**24U4PHYDSE201**					
Course Level	**300**					
Course Summary	This course provides a comprehensive introduction to computational methods in physics, encouraging students to become proficient in using computers as tools to solve real-world physics problems. The emphasis on algorithm development allows students to build a strong foundation for future research or applications in computational physics.					
Semester	4	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	**0**	**1**	**0**	**75**
Pre-requisites, if any	Basic knowledge of Calculus					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	To gain a foundational understanding of computational methods in physics.	U	1, 2, 3
2	To Develop the ability to create and implement algorithms for solving physics problems	A, S, C	1, 2, 3
3	To Gain experience in applying numerical methods to a range of physical scenarios.	A	1, 2, 3
4	To develop computational solutions for complex physics problems independently.	C	1, 2, 3

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Algebraic and Transcendental Equations and Curve Fitting**		**15**	
	1.1	Bisection Method - Newton Raphson method.	3	1
	1.2	Gauss elimination method with pivoting -Gauss-Jordan method for matrix inversion- Gauss-Seidel iterative method	3	1
	1.3	Power method and Jacobi's method to solve eigenvalue problems.	5	1
	1.4	Least squares Regression- fitting a straight line and a parabola	4	1
2	**Interpolation and Numerical Calculus and Differential Equations.**		**16**	
	2.1	Finite difference operators - Newton's forward difference and backward difference interpolation formulae.	4	1, 2
	2.2	Newton's divided difference interpolation polynomial - Cubic spline method.	4	1, 2
	2.3	Numerical Differentiation using finite differences.	4	1, 2
	2.4	Newton Cotes general quadrature formula [Concept only] – Trapezoidal rule, Simpson's 1/3 rule, Simpson's 3/8 rule.	4	1, 2

3	**Numerical Solutions of Differential Equations**		**14**	
	3.1	Euler's method – Modified Eulers Method – Runge Kutta method –4th order. Concepts of Stability.	7	1, 2
	3.2	Elementary ideas and basic concepts in finite difference method – Schmidt Method. Five Point Formula.	7	1, 2
4	**Practicum/Practical**		**30**	
	4.1	Study the Simple Harmonic Motion of a loaded spring using Euler method. Write the algorithm/Computer Programme and execute.		3, 4
	4.2	Solution of Laplace equation - Algorithm and Program.		3, 4
	4.3	Solution of diffusion equation - Algorithm and Program.		3, 4
	4.4	Study the EM oscillations in LC circuit using RK method. Write the algorithm and Programme.		3, 4
	4.5	Find the unknown resistance using Wheatstone bridge arrangement- use Gauss elimination method – write the algorithm and Programme.		3, 4
	4.6	Determine the maximum or minimum values from a given set of data –equal interval- Using interpolation. Write the algorithm and Programme.		3, 4
	4.7	Determine the maximum or minimum values from a given set of data –unequal interval- Using interpolation. Write the algorithm and Programme.		3, 4
	4.8	Find the area common to a circle and an ellipse using trapezoidal rule. Write the algorithm and Programme.		3, 4
	4.9	Determination of the time taken by a particle under non-uniform motion to travel a particular distance using Simpson's rule. Write the algorithm and Programme.		3, 4
	4.10	Fit a parabola to the data connecting the length and period of a simple pendulum. Write the algorithm and Programme.		3, 4
5	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, Presentations, Discussions
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 marks** **Formative assessment** ● Quiz ● Assignment ● Seminar **Summative assessment** ● Written test **Practical:15 marks** ● Lab involvement ● Viva
	B. End Semester Examination (ESE) **Theory: 50 marks, duration 1.5 hrs** ● Short answer type questions: Answer any 7 questions out of 10(7*2=14) ● Short essay-type questions: Answer any 4 questions out of 6(4*6=24) ● Essay type questions: Answer any 1 question out of 2(1*12=12) **Practical: 35 marks, duration 2 hrs** ● Lab Exam: 30 marks ● Record: 5 marks

Textbooks

1. Sastry, S. S.. Introductory Methods of Numerical Analysis. India, PHI Learning, 2012.
2. Sankara Rao S. Numerical Methods For Scientists And Engineers PHI Learning Pvt. Ltd., 2017.

3. Verma, R. C.. Computational Physics: An Introduction. India, New Age International, 2007.

References

1. Pang, Tao. An Introduction to Computational Physics. Spain, Cambridge University Press, 2006.
2. Sauer Timothy Numerical Analysis, 3rd edition, Pearson, 2017.

<table>
<tr><td>Programme</td><td colspan="6">BSc (Hons) Physics</td></tr>
<tr><td>Course Name</td><td colspan="6">Exploring the Cosmos: Observations, Celestial Bodies, and Cosmic Evolution</td></tr>
<tr><td>Type of Course</td><td colspan="6">DSE</td></tr>
<tr><td>Course Code</td><td colspan="6">24U4PHYDSE202</td></tr>
<tr><td>Course Level</td><td colspan="6">200</td></tr>
<tr><td>Course Summary</td><td colspan="6">The course is structured to encourage the students to explore and appreciate the night sky by understanding the celestial coordinates and using diverse tools of astronomy. The course provides the students in the vast realm of astronomy, imparting a deep understanding of the structure and the evolution of stars. An introduction to origin and evolution of the Universe is also detailed in this course</td></tr>
<tr><td>Semester</td><td>4</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>3</td><td>0</td><td>1</td><td>0</td><td>75</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">Knowledge of Basic Mathematics and Physics</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	To understand the different celestial coordinate systems	U	1, 2
2	To discuss the different astronomical distance for estimating the locations and assess the observability of objects in the night sky	U, A	1, 2
3	To discuss astronomy in different bands of wavelength	U, A	1, 2
4	To analyse the different kinds of telescope and the basic principles of the working of telescopes.	U, A, An	1, 2, 3
4	To help the students to comprehend the origin and evolution of stars and galaxies and to develop scientific attitude and aptitude	U, A, An	1,2,3

5	To explain the process of energy production in stars	U	1, 2
6	To gain a basic understanding of the origin and evolution of the Universe and established theories behind	U, An	1, 3
7	To identify different types of galaxies based on their morphology	U	1
8	To gain expertise in handling scientific tools for observational astronomy	U, A, An	1, 2,3
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Observing night sky**		**16**	
	1.1	Role of Astronomy; Concept of Celestial sphere; Celestial coordinate system-Equatorial coordinate systems (RA and DEC); Ecliptic, Circumpolar stars, Seasons, Equinoxes and Solistices; Constellations-Orion, Ursa Major, Crux, Zodiac	6	1
	1.2	Astronomical Units: AU, Parsec and light year (definition only), Trigonometric parallax method (distance to nearby stars); Basic Terms: Flux, Luminosity; Stellar Magnitudes: Absolute and Apparent magnitudes, Distance Modulus; Observing through the atmosphere-Electromagnetic Spectrum and astronomy in different wavelengths; Other forms of energy-cosmic rays, neutrinos, gravitational radiation (general idea)	6	2
	1.3	Telescopes (qualitative only) - optical telescopes-reflectors and refractors, Basic definitions - Aperture, Resolving Power, Light gathering power, focal ratio, Field of View (FOV); Mounting of telescopes-equatorial and alt-azimuth, radio telescopes, X-ray telescopes, space-based observatories - Hubble Space Telescope as an example, India's contribution -GMRT, AstroSAT (general information)	4	3
2	**Stars and Galaxies**		**19**	

	2.1	Spectra-Emission and Absorption spectrum, Blackbody radiation spectrum; Planck's radiation law (derivation not required); Stefan-Boltzmann equation connecting stellar luminosity, stellar radius, and temperature	3	3
	2.2	Stellar classification of stars-Harvard spectral classification, colour and temperature; Hertzsprung-Russel Diagram	3	3
	2.3	Stellar Evolution- Birthplace of Star, Protostar, Main Sequence Phase, Giant Phase, Final Stages of Star Depending on Its Mass –Planetary Nebula, White Dwarf, Supernova, Neutron Stars, Pulsars, Black Holes-Event Horizon and The Schwarzschild Radius	4	4
	2.4	Energy production inside stars- Thermonuclear fusion. Hydrogen burning. p-p chain. CNO cycle.	3	5
	2.5	Galaxy Morphology, Hubble's Classification of Galaxies	3	6
	2.6	Spiral Galaxy-The Milky Way Galaxy, Stars, Gas and Dust in the Galaxy, Spiral Arms	3	6
3	**Universe on large scales**		**10**	
	3.1	Distance Measurement using Cepheid Variables; Hubble's Law (Distance- Velocity Relation)	5	7
	3.2	Standard Big Bang model of the Universe	2	7
	3.3	The expansion of the Universe-- CMBR, redshift	3	7
4	**Practical**		**30**	1,2,3, 8
	1	Find the Orion Constellation. Name three stars in the belt and prepare a report of these stars as pointer stars		

	2	Classification of stars based on their spectra		
	3	Distance determination to Cepheid variables based on their light curves		
	4	Learn to use any astronomical software –any one activity		
	5	Illustration of visible spectrum using prism and telescope		
	6	Use online lunar maps or software to identify and classify craters on the moon's surface. Discuss their sizes, apparent ages, and what they can tell us about the moon's history.		
	7	Using a star map, find and draw at least five constellations in the night sky.		
	8	Observe and sketch the map of constellations observable in any one night		
	9	Observatory visit		
	10	Telescope making workshop		
	11	Astrophotography-Night Sky Photography		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Tutorial,

Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 marks** **Formative assessment** ● Quiz ● ·Assignment **Summative assessment** ● Written test **Practical: 15 marks** ● Lab involvement ● Viva
	B. End Semester Examination (ESE) **Theory: 50 marks, duration 1.5 hrs** ● Short answer type questions: Answer any 7 questions out of 10(7*2=14) ● Short essay-type questions: Answer any 4 questions out of 6(4*6=24) ● Essay type questions: Answer any 1 question out of 2(1*12=12) **Practical: 35 marks, duration 2 hrs** ● Lab Exam:30 marks ● Record: 5 marks

Textbooks

1. Fundamental of Astronomy (Fourth Edition), H. Karttunen et al. Springer
2. Moché, Dinah L. Astronomy. A self-teaching guide, 8th Edition, 2014.
3. Morison, Ian. Introduction to astronomy and cosmology. John Wiley & Sons, 1st Edition 2008.
4. Narlikar, Jayant Vishnu. An introduction to cosmology. Cambridge University Press, 3rd Edition, 2002.

References

1. Padmanabhan, Thanu. An invitation to astrophysics. Vol. 8. World Scientific, 2006.
2. Karttunen, Hannu, et al., eds. Fundamental astronomy. Berlin, Heidelberg: Springer Berlin Heidelberg, 6th Edition 2017.

St Thomas College Palai Autonomous

Programme	**BSc (Hons) Physics**					
Course Name	**Optoelectronics**					
Type of Course	**DSE**					
Course Code	**24U4PHYDSE203**					
Course Level	**200**					
Course Summary	The course aims to develop an understanding the physics of semiconductor junctions, and applications of modern electronic and optoelectronic semiconductor devices such as LED, photodetectors and Solar cells					
Semester	**4**	Credits			**4**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	**0**	**1**	**0**	**75**
Pre-requisites, if any	Basic Solid State Physics					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	To explain the theoretical basis and the physics behind the semiconductor optoelectronic devices	K, U	1, 2
2	To appreciate the working mechanism of various types of LEDs	U, Ap	1, 2
3	To analyse the basic concepts of light emitting devices, photodetectors and energy harvesting devices	U, A, An	1, 2
4	To develop practical knowledge and an understanding of the trade-offs when using the optoelectronic devices in their respective applications.	U, A, An, S	1, 2
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	**Units**	**Course description**	**Hrs**	**CO No.**
1	**Semiconductor Science and pn junction principles**		**16**	
1	1.1	Energy Band Diagrams of Semiconductors, Semiconductor statistics	2	1
	1.2	Extrinsic Semiconductors -. n-Type and p-Type Semiconductors, Compensation Doping, Nondegenerate and Degenerate Semiconductors, Energy Band Diagrams in an Applied Field	4	1
	1.3	Direct and Indirect Bandgap Semiconductors: E–k Diagrams	2	1
	1.4	pn Junction Principles - Open Circuit, Forward Bias and the Shockley Diode Equation, Minority Carrier Charge Stored in Forward Bias, Recombination Current and the Total Current, pn junction reverse current, pn Junction Dynamic Resistance and Capacitances	6	1
	1.5	PN junction band diagram-forward and reverse bias, heterojunctions	2	1
2	**Light Emitting Diodes**		**12**	
	2.1	Homojunction LEDs, Heterostructure High Intensity LEDs, Output Spectrum, Quantum well high density LEDs	6	2, 3
	2.2	LED materials, LED structures, LED Efficiencies and Luminous Flux, Basic LED Characteristics, LEDs for Optical Fiber Communications, Phosphors and White LEDs	6	2, 3
3	**Photodetectors & Photovoltaic Devices**		**17**	
	3.1	Principle of the pn Junction Photodiode - Basic Principles, Energy Band Diagrams and Photodetection Modes, Current-Voltage Convention and Modes of Operation	6	3
		Absorption Coefficient and Photodetector Materials, Quantum Efficiency and Responsivity	2	3

	3.2	The pin Photodiode, Avalanche Photodiode, Heterojunction Photodiodes, Schottky Junction Photodetector, Phototransistors, Photoconductive Detectors and Photoconductive Gain, Basic Photodiode Circuits, Noise in Photodetectors. The pn Junction and pin Photodiode	5	3
	3.3	Solar Cell-Basic Principle, Operating Current and Voltage and Fill Factor, Equivalent Circuit of a Solar Cell, Solar Cell Structures and Efficiencies	4	3
4	**Practicals**		**30**	
	4.1	Study the V-I characteristics of LEDs emitting different wavelengths and compare their turn-on voltages.		4
	4.2	Determination of Plank's constant using LED.		4
	4.3	Design an LED driver circuit employing a constant current source using an opamp and transistor and study its performance.		4
	4.4	Design a photoconductor (LDR) circuit using opamp in the trans impedance mode and study its performance		4
	4.5	Study the performance of a photodiode connected in photovoltaic mode using an opamp.		4
	4.6	Study the performance of a photodiode connected in photoconductive mode using an opamp.		4
	4.7	Compare the performance of a phototransistor connected in common emitter and common collector configurations.		4
	4.8	Design a pyroelectric sensor circuit in voltage mode / current mode using an opamp and study its performance.		4
	4.9	To characterize the solar cell and find out the FF and Efficiency of a solar Cell.		4
	4.10	Construct an optical communication system by transmitting a modulated LED light through an optical fibre and detect the transmitted light intensity using a photodetector.		4
	4.11	Determine the current transfer ratio of an Optocoupler (PC817 / 4N35) and draw the input, output and transfer characteristics curves.		4

	4.12	Use the optocoupler 6N137 as logic gate and verify its truth table.		4
5	**Teacher Specific Content**			

Teaching and Learning Approach	Classroom Procedure (Mode of transaction) Lecture, use of demonstrations and animations/videos
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 marks** **Formative assessment** ● Quiz ● Assignment ● Seminar **Summative assessment** ● Written test **Practical: 15 marks** ● Lab involvement ● Viva
	B. Semester End Examination **Theory: 50 marks, duration 1.5 hrs** ● Short answer type questions: Answer any 7 questions out of 10(7*2=14) ● Short essay-type questions: Answer any 4 questions out of 6(4*6=24) ● Essay type questions: Answer any 1 question out of 2(1*12=12) **Practical: 35 marks, duration 2 hrs** ● Lab Exam:30 marks ● Record: 5 marks

Textbook

1. Kasap S.O., Optoelectronics and Photonics: Principles and Practices Pearson Education Ltd. 2nd Edition, 2012.

References

1. Bhattacharya Pallab, Semiconductor Optoelectronic Devices Pierson Education, Second Edition, 2nd Edition 2017.
2. Wilson John, Hawkes John, Optoelectronics: An Introduction Prentice Hall 2nd Edition 1989.
3. Sze, S. M., Lee M. K. Semiconductor Devices: Physics and Technology John Wiley and Sons 3rd Edition 2015.
4. Saleh B. E. A., M. C. Teich, Fundamentals of Photonics John Wiley and Sons 2nd Edition 2012.

St Thomas College Palai Autonomous

Programme	**BSc (Hons) Physics**				
Course Name	**Material Characterization Techniques**				
Type of Course	**DSE**				
Course Code	**24U4PHYDSE204**				
Course Level	**200**				
Course Summary	The course aims to introduce students to different material characterization techniques and make them familiar with the underlying principles. The students should be able to independently identify and apply the best technique or set of techniques for specific problems.				
Semester	4	Credits		4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others
		3	**0**	**1**	**0**
					75
Pre-requisites, if any	Basic knowledge of Physics and Mathematics				

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Describe the modern analytical techniques used in Material Characterisation.	U	1, 3
2	Determine the crystallite size and lattice parameters of a crystal from X-ray Diffraction method.	U, A	1, 2, 3
3	To explain different spectroscopic techniques used in material characterisation.	U	1,3
4	To assess the surface morphology, elemental composition, physical	U, A, An	1, 2, 3

	properties, and dynamic behaviour of a material by different microscopic methods.		
6	To interpret the thermal properties of a material by using different thermal analysis methods.	U, A, An	1, 2, 3
7	To gain a better understanding of different resonance spectroscopic methods.	U, A, An	1, 2, 3
8	To analyse the results obtained from the different Material characterisation Techniques.	U, A, An	1, 2, 3
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	**Units**	**Course description**	**Hrs**	**CO No.**
1	**X-ray Diffraction methods and Spectroscopic Techniques.**		**15**	
	1.1	X-ray diffraction, Bragg's law.	2	1,2
	1.2	Experimental techniques- Laue method, Standard XRD pattern, Determination of crystallite size and lattice parameters of a crystal.	3	2
	1.3	Spectroscopic Techniques: Instrumentation and Spectral analysis of (a)Ultraviolet and visible absorption, (b) Infrared absorption spectra analysis.	4	1, 3
	1.5	Raman Spectroscopy- Basic idea, Instrumentation and Spectroscopic analysis.	3	3
	1.6	Photoluminescence, Basic principles, Instrumentation.	3	3
2	**Electron Microscopy, Energy Dispersive and X-ray Photoelectron Spectroscopy**		**15**	

	2.1	Electron microscopy: Generation of an electron beam, Interaction of an electron beam with a sample.	3	4
	2.2	Scanning Electron Microscopy- Instrumentation, Transmission Electron Microscopy, Instrumentation.	3	4
	2.3	Energy Dispersive Spectroscopy- Energy dispersive spectra analysis. X-ray Photoelectron Spectroscopy, Basic Principle, Instrumentation.	4	5
	2.4	Scanning Probe Microscopy, Principle, Instrumentation, Scanning Tunnelling Microscopy, Principle, Instrumentation, Atomic Force Microscopy, Basic Idea.	5	5
3	**Thermal Analysis and Resonance Spectroscopy**		**15**	
	3.1	Thermal Analysis: Common Characteristics, Instrumentation	2	6
	3.2	Differential Thermal Analysis and Differential Scanning Calorimetry, Working principles.	4	6
	3.3	Thermogravimetry, instrumentation, Interpretation of thermogravimetric Curves.	3	6
	3.4	Resonance Spectroscopy: Nuclear Magnetic Resonance spectroscopy, Basic Principle and Instrumentation. Electronic Spin Resonance Spectroscopy (ESR), Instrumentation	6	7
4	**Practicals** (For all the analysis, the required spectrum/image should be provided to the students)		**30**	
	4.1	Determination of the lattice parameters and crystal class identification using the XRD pattern		8
	4.2	Determination of the crystallite size of the given material using the XRD pattern.		8

	4.3	Determination of microstrain from XRD data.		8
	4.4	Determination of the optical bandgap of the given material by analyzing the UV-visible spectrum.		8
	4.5	Determination of the functional groups present in the given material by the analysis of Fourier Transform Infrared Spectrum.		8
	4.6	Particle size determination of the given nanomaterial using Transmission Electron Microscopy image.		8
	4.7	Elemental Composition Analysis of the material using EDS spectrum.		8
	4.8	Morphology/microstructure of the given materials using SEM image.		8
	4.9	Thermal Analysis of the given material-TGA-DTA-DTG.		8
	4.10	Identification of the modes of vibration of the given sample using Raman spectroscopy.		8
5	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Discussions, Demonstrations
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 marks** **Formative assessment** • Quiz • Assignment • Seminar

	Summative assessment • Written test **Practical:15 marks** • Lab involvement • Viva
	B. End Semester Examination (ESE) **Theory: 50 marks, duration 1.5 hrs** • Short answer type questions: Answer any 7 questions out of 10(7*2=14) • Short essay-type questions: Answer any 4 questions out of 6(4*6=24) • Essay type questions: Answer any 1 question out of 2(1*12=12) **Practical: 35 marks, duration 2 hrs** • Lab Exam:30 marks • Record: 5 marks

Textbook

1. Leng Y. Materials Characterization: Introduction to Microscopic and Spectroscopic Methods Wiley VCH, Second Edition 2013.

References

1. Sultan K. Practical Guide to Materials Characterization: Techniques and Applications, Wiley VCH, First Edition 2022.
2. Evans C., Brundle R., Wilson S. Encyclopedia of Materials Characterization: Surfaces, Interfaces, Thin Films (Materials Characterization Series):, Butterworth Heinemann 1992.
3. Pavia D. L., Lampman G. M., Kriz, G. A. and J. R. Vyvyan, Introduction to Spectroscopy, Brooks/Cole Fifth edition 2014.
4. Kaufmann E. N. Characterization of Materials, Wiley Second edition 2012.
5. Lund A., Shiotani M., Shimada S. Principles and Applications of ESR Spectroscopy, Springer First edition 2011.

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<table>
<tr><td>Programme</td><td colspan="6">BSc (Hons) Physics</td></tr>
<tr><td>Course Name</td><td colspan="6">Theory of Relativity</td></tr>
<tr><td>Type of Course</td><td colspan="6">DSE</td></tr>
<tr><td>Course Code</td><td colspan="6">24U4PHYDSE205</td></tr>
<tr><td>Course Level</td><td colspan="6">200</td></tr>
<tr><td>Course Summary</td><td colspan="6">Course aims to introduce the student to elements of relativity, starting with special relativity. Essential tensor algebra and calculus will be introduced equipping the learner with relativistic invariant formulation. Basics of general theory of relativity is also introduced to the point that enables further study of advanced topics.</td></tr>
<tr><td>Semester</td><td>4</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>3</td><td>0</td><td>1</td><td>0</td><td>75</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6"></td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Understand the basics of special relativity	U An E	1, 2
2	Equip with special relativistic invariant description of vectors and tensors	An E	1, 2
3	Introduce the fundamentals of calculus in curved spaces	U An	1, 2
4	Understand curvature and description of equations of gravity	An E C	1, 2
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom Transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Special relativity**		18	
	1.1	Special Relativity: Postulates	1	1
	1.2	Time Dilation, Length Contraction, Twin Paradox	3	1
	1.3	The Lorentz Transformation	1	1
	1.4	Definition of an inertial observer in SR, New units, Spacetime diagrams	3	1
	1.5	Construction of the coordinates used by another observer, Invariance of the interval, Invariant hyperbolae	2	1
	1.6	The velocity composition law	1	1
	1.7	**Practicum** (Problems)	7	1
2	**Vector and tensor analysis in special relativity**		20	
	2.1	Definition of a vector, Vector algebra	2	2
	2.2	The four-velocity, The four-momentum,	2	2
	2.3	Scalar product, Applications, Photons	1	2
	2.4	The metric tensor, Definition of tensors	2	2
	2.5	The (0, 1) tensors: one-forms, The (0, 2) tensors	1	2
	2.6	Metric as a mapping of vectors into one-forms	2	2
	2.7	(M, N) tensors, Index ‘raising’ and ‘lowering’, Differentiation of tensors	2	2
	2.8	**Practicum** (Problems)	8	2
3	**Calculus in curved space**		19	
	3.1	On the relation of gravitation to curvature	1	3
	3.2	Tensor algebra in polar coordinates	2	3

	3.3	Tensor calculus in polar coordinates	3	3
	3.4	Christoffel symbols and the metric	3	3
	3.5	Noncoordinate bases	2	3
	3.6	**Practicum** (Problems)	8	3
4	**Curvature and Einstein equations**		**18**	
	4.1	Covariant differentiation	2	3, 4
	4.2	Parallel-transport, geodesics, and curvature	4	4
	4.3	The curvature tensor	2	4
	4.4	Bianchi identities: Ricci and Einstein tensors, Curvature in perspective	1	4
	4.5	Purpose and justification of the field equations, Einstein's equations	2	4
	4.6	**Practicum** (Problems)	7	4

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Tutorials, Seminars/ Presentations Activities, Practical sessions
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Formative assessment** **Theory: 30 marks** ● Quiz ● Two Assignments ● Seminar ● Worksheets **Summative assessment** ● Written tests
	B. End Semester Examination: 70 marks **Written exam, duration 2 hrs**

	● Short answer type questions: Answer any 7 questions out of 10(7*2=14) ● Short essay-type questions: Answer any 4 questions out of 6(4*6=24) ● Problem type questions: Answer any 4 questions out of 7(4*5=20) ● Essay type questions: Answer any 1 question out of 2(1*12=12)

Textbooks

1. Beiser, Arthur. "Concepts of modern physics." (2003). (Units 1.1 - 1.3)
2. Schutz, Bernard. *A first course in general relativity*. Cambridge university press, 2022.

References

1. Weinberg, Steven. "Gravitation and cosmology: principles and applications of the general theory of relativity." (1972).
2. Carroll, Sean M. "Lecture notes on general relativity." *arXiv preprint gr-qc/9712019* (1997).
3. Classical Theory of Fields, Vol. 2: L. D. Landau and E. M. Lifshitz, Oxford: Pergamon Press.
4. Thorne, Kip S., Charles W. Misner, and John Archibald Wheeler. *Gravitation*. San Francisco: Freeman, 2000.

St Thomas College Palai Autonomous

Programme	**BSc (Honours) Physics**					
Course Name	**Continuous and Discrete Systems**					
Type of Course	**DSE**					
Course Code	**24U4PHYDSE205**					
Course Level	**200**					
Course Summary and Justification	This course provides essential understanding of continuous and discrete electronic systems.					
Semester	4	Credits			4	Total Hours
Course details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	1	0	75
Pre-requisites	Knowledge in basic electronics					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Illustrate the basic concept of BJT and its amplifier configuration.	U	1,2
2	Analyse the properties and applications of operational amplifiers	U	1, 2
3	Summarize the design and operation of registers and counters.	An	1, 2
4	Develop hands-on circuits that involve the design, implementation, and testing.	C	1, 2, 10

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Unit	Course description	Hrs	CO No:
1	1.1	Bipolar Junction Transistor, Operating point of BJT, Modes of Operation, Voltage divider biasing, RC Coupled Amplifier	7	1
	1.2	Principle of Sinusoidal Oscillators - Barkhausen Criteria, RC Phase Shift Oscillator	5	1
	1.3	Block diagram representation of a typical op-amp – schematic symbol - A general purpose IC Op amp – IC 741, pin diagram.	1	1

		Op-Amp parameters - input offset voltage and offset current, common mode rejection ratio (CMMR), slew rate		
	1.4	Equivalent circuit of an op-amp, Open-loop op-amp Configurations, Closed-loop non-inverting and inverting amplifiers	2	1
2	2.1	Op-amp Circuits performing mathematical operations- adder, subtractor Integrator, Differentiator	4	2
	2.2	Op-Amp based oscillator circuits: Wein Bridge Oscillator – Colpitts Oscillator, Phase shift Oscillator	4	2
	2.3	Active filters using op-amp (High pass, Low pass, Band pass Filters), Ideal and Practical characteristics	3	2
	2.4	Non-linear Applications – Comparator Introduction to NE555, Astable multivibrator using 555	4	2,3
3	3.1	Introduction to Number Systems: Binary, decimal, octal, and hexadecimal systems, 1's complement, 2's complement, Binary Addition, subtraction	3	3
	3.2	Familiarization of Logic Gates and Boolean Algebra (Rules, Laws and Theorems), K-map simplification using SOPs. Half adder, Full Adder	4	3
	3.3	Introduction to Flip-Flop, types- SR, D, JK, T. Serial in Serial out Shift registers	4	3
	3.4	Counters: Ring counter, Johnson counter and applications,2 bit Synchronous counter, Asynchronous Decade Counter	4	3
4	4.1	**Practical using Components and ICs** **(Any 4)** 1. Op-amp – Square Wave Generator 2. Op-amp – Digital/Analog Converter 3. Op-amp –Summing Amplifier 4. OP-Amp – inverter, non-inverter, buffer Amplifier 5. Op-amp Phase Shift Oscillator 6. Astable multivibrartor using 555	30	4
	4.2	**Digital (Any 4)** 7. Realization of logic gates – AND, OR and NOT – Using universal gates 8. Half Adder 9. Full adder 10. Verification of De Morgan's theorems – Using IC 7400 11. JK Flip Flops using IC 7400 & 7410 – Verification of truth table 12. Two bit synchronous counter		

5	**Teacher Specific Content**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Leverage a blended learning approach with a mix of lectures, interactive discussions, and hands-on lab sessions
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: - 25 Marks** 1. Internal Test – One MCQ based and one extended answer type 2. Seminar Presentation – a real time application of emerging technology to be identified and present it as seminar **Practical: 15 Marks** Components for assessment (suggestions): A combination of quizzes, assignments, Performance, Case study **B. End Semester Examination (ESE)** 1.Written Test (50 marks)**, duration 1.5 hrs** a. MCQ - 10 Marks b. Short answer questions (4 out of 6 questions)-4x5=20 marks c. Essay questions -2 out of 4 - 2x10=20 marks 2. Practical Exam (35 marks)**, duration 2 hrs** a. Viva b. Lab report c. Demonstration

References

1. Mottershead, Allen. Electronic devices and circuits. Goodyear Publishing Company, 1973.
2. Gayakwad, Ramakant A. "Op-amps and linear integrated circuit." (2012).
3. Floyd, Thomas L. Digital fundamentals, 10/e. Pearson Education India, 2011.

Suggested Readings

1. Malvino, A. P., & Leach, D. P. (2017). "Digital Principles and Applications." Tata McGraw-Hill Education.
2. Millman, Jacob. Electronic Devices and Circuits, Jacob Millman and Christos C. Halkias. McGraw-Hill, 1967.
3. Pandiankal Abhilash: Filters, ebook – kindle edition, kindle store

St Thomas College Palai Autonomous

Programme	**BSc (Hons) Physics**					
Course Name	**Current Electricity**					
Type of Course	**DSE**					
Course Code	**24U4PHYDSE207**					
Course Level	**200**					
Course Summary	This course provides a comprehensive exploration of the principles, techniques, and applications of electric current.					
Semester	**4**	Credits			**4**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	**0**	**1**	**0**	**75**
Pre-requisites, if any	Nil					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains*	PO NO.

1	To gain knowledge of various circuit parameters including current, voltage, resistance	U	1, 2
2	To solve the complex electrical networks by using the Network Theorems	U, A	1, 2
3	To describe the basic principles of linear and passive energy storage elements: Capacitors and Inductors	U	1, 2
4	To explain the chemical effects of electric current and analyse the daily life situations that involve the chemical effects	U, A, An	1, 2
5	To explain the transient and AC response of the RL, RC series and LCR circuits.	U, A, An	1, 2
6	To understand the basics of thermoelectricity.	U	1, 2
7	To apply the theoretical knowledge to solve and analyse different circuits	A, An	1,2

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom Transaction (Units)

Module	**Units**	**Course description**	**Hrs**	**CO No.**
1	**Electric Current and Network Theorems**		**11**	
	1.1	Modern electron theory of electricity- The idea of electric potential	1	1
	1.2	Resistance, Effect of Temperature on Resistance, Temperature coefficient of Resistance	2	1
	1.3	Open and Short circuits equivalent resistance- Voltage divider circuits	2	1
	1.4	Kirchhoff's laws- sign convention, Ideal voltage source and current source -	2	1
	1.5	Superposition theorem, Thevenin’s theorem - Norton’s theorem - Maximum power transfer theorem (Proofs not needed)	4	1, 2
2	**Capacitors & Inductors, Chemical effects of Electric current**		**10**	

	2.1	Capacitor- Capacitance-Capacitance of an isolated sphere-	1	3
	2.2	parallel plate capacitor, uniform dielectric medium, medium partly air, composite medium, multiple and variable capacitor	2	3
	2.3	Faradays Law of E.M induction-Lez's law, Induced emf, Self-inductance, coefficient of Self-inductance	2	3
	2.4	Mutual inductance, coefficient of mutual inductance	2	3
	2.5	Electrical conductivity of an electrolyte, Arrhenius theory of electrolytic Dissociation	3	4
3	**3.1 Transient Current and Alternating Current**		**19**	
	3.1.1	Growth and decay of current in an LR circuit- Charging and discharging of a capacitor through a resistor.	3	5
	3.1.2	Growth and decay of charge in an LCR circuit.	3	5
	3.1.3	EMF induced in a coil rotating in a magnetic field	2	5
	3.1.4	AC applied to resistive, inductive and capacitive circuits, AC applied to LR and RC circuits	4	5
	3.1.5	Analysis of LCR series circuits - LCR parallel circuits-resonance – comparison.	3	5
	3.1.6	Power in ac circuits - Wattless current - choke coil - transformer on no load- skin effect.	4	5
	3.2 **Thermoelectricity**		**5**	
	3..2.1	Seebeck effect - Laws of thermo emf - Peltier effect-Thomson effect- Thermoelectric diagrams -Thermocouple (qualitative study)	3	6
	3.2.2	Explanation of thermoelectric effects based on electron theory	2	6
4	**Practical**		**30**	

	1	Verification of Thevnin's and Norton's Theorem		7
	2	Verification of superposition and Maximum Power transfer theorem		7
	3	Conversion Galvanometer into Voltmeter		7
	4	Conversion Galvanometer into Ammeter		7
	5	LCR Series and Parallel Resonant Circuit Analysis		7
	6	Potentiometer- Measurement of Resistance of wire.		7
	7	Potentiometer-Calibration of low range voltmeter		7
	8	Potentiometer-Calibration of Ammeter		7
	9	Potentiometer-Calibration of high range voltmeter.		7
	10	Carey Fosters Bridge – Resistivity of a given material.		7
	11	Determination of self-inductance of coil using Andersons bridge		7
	12	Characteristics of thermistor.		7
5	**Teacher Specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Tutorials, Seminars/ Presentations, Activities, Practical sessions
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory:25 marks**

	Formative assessment • Quiz • Assignment • Seminar **Summative assessment** • Written test **Practical:15 marks** • Lab involvement • Viva
	B. End Semester Examination (ESE) **Theory: 50 marks, duration 1.5 hrs** • Short answer type questions: Answer any 7 questions out of 10(7*2=14) • Short essay-type questions: Answer any 4 questions out of 6(4*6=24) • Essay type questions: Answer any 1 question out of 2(1*12=12) **Practical: 35 marks, duration 2 hrs** • Lab Exam:30 marks • Record: 5 marks

Textbooks

1. Theraja, B. L. A textbook of electrical technology. S. Chand Publishing, 2014
2. Murugeshan, R. Electricity and Magnetism. S. Chand Publishing, 2017

References

1. Shankar R. Fundamentals of Physics II – Electromagnetism, Optics, and Quantum Mechanics: (The Open Yale Courses Series) Yale University Press 2019.
2. Neil Storey, Electronics: A systems Approach Pearson Education Limited; 6th edition 2017.
3. Tewari K. K. Electricity and Magnetism, S. Chand. 2022

St Thomas College Palai Autonomous

Programme	
Course Name	**Basic Electronics and Electricity**
Type of Course	**DSC B**
Course Code	**24U4PHYDSC202**
Course Level	**200**
Course Summary	This course gives an overview of the various circuit parameters and components involved in electricity and enhances the ability to analyse different electrical circuits. This course also provide a comprehension of the fundamentals of Solid state physics for the learner.

Semester	4	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	**0**	**1**	**0**	**75**
Pre-requisites, if any	Nil					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	To gain in depth knowledge of various circuit parameters including current, voltage, resistance	U	1, 2
2	To explain the idea of ac currents through LR, CR and LCR	U, A, An	1, 2
3	To design different types of rectifier and Zener diode circuits and analyse voltages, currents their time graphs	A, An, E, C	1, 2, 3
4	To understand the working of a transistor as an amplifier and the basic ideas of FET	U, An	1, 2, 3
5	To study the basic ideas of Op-amp	U, A, An, E	1,2,3
6	To implement the concepts of Principles of Diodes and	U, A, An, E	1, 2, 3,

	Transistors and analyse the circuit parameters for different electronic circuits		9
***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)**			

COURSE CONTENT

Content for Classroom Transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Basic Concepts of Electricity**		**18**	
	1.1	Modern Electron Theory of electricity- The idea of an electric potential	3	1
	1.2	Resistance, Effect of Temperature on Resistance, Temperature coefficient of Resistance, Thermistor.	3	1
	1.3	Open and Short circuits equivalent resistance, Voltage divider circuits	5	1
	1.4	EMF induced in a coil rotating in a magnetic field	2	2
	1.5	AC applied to resistive, inductive and capacitance circuits - AC applied to LR and RC circuits. Analysis of LCR series circuits - LCR parallel resonant circuit – comparison.	5	2
2	**Applications of Diodes**		**12**	
	2.1	Rectification - Half wave, - Nature of rectified output, Efficiency & Ripple factor	3	3
	2.2	Full wave, Centre tapped, Bridge rectifier circuits - Nature of rectified output, Efficiency & Ripple factor	3	3
	2.3	Filter Circuits – Capacitor filter	2	3

	2.3	Zener diode and its reverse characteristics. Zener diode as a voltage regulator.	4	3
3	**Transistor, FET and Op-Amp**		**15**	
	3.1	Bipolar junction transistors, Transistor, CE configurations and their characteristics, applications	4	4
	3.2	Current gain β. CE amplifier with voltage biasing	3	4
	3.3	FET (basic idea)	2	4
	3.4	OP-amp- Symbol and terminals. Characteristics of ideal OP-amp, CMRR. Applications -Inverting, Non-inverting and Buffer amplifiers.	6	5
4	**Practicals**		**30**	
	1	Conversion Galvanometer into Voltmeter/Ammeter		6
	2	Diode Characteristics – Forward - Study of dynamic and static properties		6
	3	Zener Diode Characteristics –Reverse – Study of dynamic and static properties		6
	4	Voltage regulator using zener diode – Study of line and load regulations		6
	5	Half wave rectifier – Study of ripple factor and load regulation with and without filter circuit		6
	6	Full wave rectifier – (center tap) – Study of ripple factor and load regulation with and without filter circuit		6
	7	Full wave rectifier – (bridge) – Study of ripple factor and load regulation with and without filter circuit		6
	8	Common Emitter – Input and output characteristics		6

	9	Common Emitter amplifier -study the amplification.		6
	10	Op Amp Inverting amplifier, Non-Inverting amplifier and Buffer amplifier		6
		Simulations using PSpice (any 4)		
5	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, Demonstration, Tutorial, Simulations, Practical
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25** **Formative assessment** ● Quiz ● Two Assignments **Summative assessment** ● Two written tests **Practical: 15** ● Lab involvement ● Viva
	B. End Semester Examination **Theory: 50 marks, duration 1.5 hrs** ● Short answer type questions: Answer any 7 questions out of 10(7*2=14) ● Short essay type questions: Answer any 4 questions out of 6(4*6=24) ● Essay type questions: Answer any 1 question out of 2(1*12=12) **Practical: 35 marks, duration 2 hrs** ● Problem solving skills:15 marks

	● Record: 2 marks

Textbooks

1. Theraja B.L., Theraja A. K. A Textbook of Electrical Technology S Chand 1999.
2. Metha V. K. Principles of Electronics S Chand; 7th edition
3. Rashid Muhammad H. Introduction to PSpice Using OrCAD for Circuits and Electronics Pearson; 3rd edition (28 August 2003)

References

1. Malvino, Leach and Saha. Digital principles and applications, (6th Edition) TMH
2. Murugeshan R. Electricity and Magnetism,
3. Salivahanan S., Arivazhagan S. Digital electronics, VPH 2010
4. M Morris Mano, D. Ciletti Michael Digital design 6th edition Visionias 2022

Programme						
Course Name	**Electrical Circuits and Network Skills**					
Type of Course	**SEC**					
Course Code	**24U4PHYSEC200**					
Course Level	**200**					
Course Summary	In this course we try to understand concepts of basic Electrical systems. We study electrical circuits and elements that are used in an electrical system. After completing the course students will be able to develop skill in constructing and servicing some home appliances.					
Semester	**4**	Credits			3	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	**0**	**0**	**0**	**45**
Pre-requisites, if any	Nil					

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains***	**PO No**
1	To gain in depth knowledge of various circuit parameters including current, voltage, resistance	U, A	1, 2
2	To familiarise with the basic devices used in the measurement of the circuit parameters	U, A	1, 2, 9
3	To solve the simple AC and DC sourced electrical circuits	A, An	1, 2, 9
4	To demonstrate the basic models of Transformers and generators	U, A, An	1, 2, 9

5	To analyse the response of inductors and capacitors with DC or AC sources	U, A, An	1, 2, 9
6	To gain hands on expertise in the basics of electrical wiring and test the operation of various protective devices and relays	A, An, E	1, 2, 9
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom Transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**1.1 Basic Electricity Principles**		**5**	
	1.1.1	Voltage, Current, Resistance, and Power.	1	1
	1.1.2	Ohm's law. Series, parallel, and series-parallel combinations.	2	1
	1.1.3	AC and DC Electricity.	1	1
	1.1.4	Familiarization with Galvanometer, multimeter, voltmeter, ammeter and watt meter	1	1, 2
	1.2 Electrical Circuits		**8**	
	1.2.1	Basic electric circuit elements and their combination.	1	3
	1.2.2	Rules to analyze DC sourced electrical circuits.	1	3
	1.2.3	Single-phase and three-phase alternating current sources.	2	3
	1.2.4	Rules to analyze AC-sourced electrical circuits.	1	3
	1.2.5	Real, imaginary and complex power components of AC source.	2	3
	1.2.6	Power factor. Saving energy and money	1	3

2	**Generators and Transformers**		**9**	
	2.1	DC Power sources. AC/DC generators. Inductance, capacitance, and impedance. Operation of transformers, Isolation Transformer	3	4
	2.2	Electric Motors: Single-phase, three-phase and DC motors. Basic design. Interfacing DC or AC	2	4
	2.3	Sources to control heaters and motors. Speed and power of ac motor. Stabilizers	1	4
	2.4	Solid-State Devices: Resistors, inductors and capacitors. Magnets Conductors, Components in Series or in shunt.	2	4
	2.5	Response of inductors and capacitors with DC or AC sources,	1	5
3	**3.1 Electrical Protection:**		**8**	
	3.1.1	Relays. Fuses and disconnect switches. Automatic main failure switches Circuit breakers. Overload devices. Relay protection device. IoT based smart Switches	2	6
	3.1.2	Ground-fault protection. Grounding and isolating. Phase reversal. Surge protection and safety measures.	1	6
	3.1.3	Electrical Wiring: Basics of wiring-Star and delta connection	3	6
	3.1.4	Voltage drops and losses across cables and conductors. Insulation.	1	6
	3.1.5	Types of Cables and its properties, Solid and stranded cable. Preparation of extension board.	1	6
	3.2 Demonstration activities of each module to be conducted in lab		**15**	
	3.2.1	Familiarise with Galvanometer, multimeter, Ammeter voltmeter and wattmeter.		2
	3.2.2	Hands on experience on electrical wiring-Basics		6
	3.2.3	Demonstration of the use of fuses and familiarisation of gauge of fuse wires		1,6
	3.2.4	Preparation of an extension board		1,6

	3.2.5	Demonstration of MCB's and ELCB's		6
	3.2.6	Calculation of Power consumption in various Electrical equipment.		3
	3.2.7	Electrical connections for home appliances		6
4	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, Tutorial, Activities, Demonstration
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 marks** **Formative assessment** ● Quiz ● Assignments ● Seminar **Summative assessment** ● MCQ Exams
	B. End Semester Examination (ESE) **Theory: 50 marks, duration 1.5 hrs** 1. Short essay type questions: Answer any 4 questions out of 5(4*5=20) 2. Application type questions: Answer any 4 questions out of 7(4*5=20) 3. Essay type questions: Answer any 1 question out of 2(1*10=10)

Text Book

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

References

1. Theraja, B. L. A Textbook of Electrical Technology-Volume I (Basic Electrical Engineering). Vol. 1. S. Chand Publishing, 2005.
2. Theraja, A. K., and R. Sedha. A Textbook of Electrical Technology. 2018.
3. Say, M. G., Performance and design of AC machines. English LB S., 1995.

St Thomas College Palai Autonomous

Programme						
Course Name	**Environmental Physics**					
Type of Course	**VAC**					
Course Code	**24U4PHYVAC200**					
Course Level	**200**					
Course Summary	Environmental physics aims at an interdisciplinary study of physical principles applied to understanding and addressing environmental challenges, encompassing topics such as climate change, air and water quality, and the dynamics of ecosystems.					
Semester	4	Credits			3	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	0	0	45
Pre-requisites, if any	**Nil**					

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	To understand the basics of the ecosystem, biodiversity, renewable and non-renewable resources.	U	3,6,7,8,10
2	To value the environmental policies and practices after analyzing the environmental pollution and its adverse effects.	U, A, An, E	1,2 3,6,7,8,10
3	To achieve Sustainable development goals by positively correlating the environment with human communities.	U, A, An	1, 2 3, 6, 7, 8,10
4	To examine the surrounding environment via field work.	U, A	1, 2, 3, 6, 7, 8, 10
5	To reframe the concepts and methods to safeguard the environment.	U, A, An, E	1, 2, 3, 6, 7, 8, 10

6	To make the community aware of the important facts about the environment and the conservation.	U, A, E	1, 2, 3, 6, 7, 8, 10
***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)**			

COURSE CONTENT

Content for Classroom Transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**1.1: Introduction to environmental studies**		**5**	
	1.1.1	Multidisciplinary nature of environmental studies	1	1, 4, 6
	1.1.2	Scope and importance; Concept of sustainability and sustainable development.	2	1, 4
	1.1.3	Structure and function of ecosystem; Energy flow in an ecosystem: food chains, food webs and ecological succession. Case studies of the following ecosystems: a) Forest ecosystem b) Grassland ecosystem c) Desert ecosystem d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)	2	1, 4
	1.2: Natural Resources: Renewable and Non-renewable Resources		**10**	
	1.2.1	Land resources and land use change; Land degradation, soil erosion and desertification. Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations	4	1, 4
	1.2.2	Water: Use and over-exploitation of surface and groundwater, floods, droughts, conflicts over water (international & inter-state).	4	1,4
	1.2.3	Energy resources: Renewable and non-renewable energy sources, use of alternate energy sources, growing energy needs, case studies.	2	1, 4
2	**Environmental Pollution and Environmental Policies & Practices**		**20**	

	2.1	Environmental pollution: types, causes, effects and controls; Air, water, soil and noise Pollution, Nuclear hazards and human health risks	8	2, 3, 6
	2.2	Solid waste management: Control measures of urban and industrial waste, Pollution case studies	4	2, 3, 6
	2.3	Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture Environment Laws: Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act. International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD).	5	2, 3, 6
	2.4	Nature reserves, tribal populations and rights, and human wildlife conflicts in the Indian context.	3	2, 3, 6
3	**Human Communities and the Environment**		**10**	
	3.1	Human population growth: Impacts on environment, human health and welfare. Resettlement and rehabilitation of project affected persons; case studies. Disaster management: floods, earthquakes, cyclones and landslides. Environmental movements: Chipko, Silent Valley, Bishnoi's of Rajasthan	5	3, 4, 5, 6
	3.2	Environmental ethics-Role of Indian and other religions and cultures in environmental conservation. Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi).	5	3, 4, 5, 6
		Activities		
	1	Write a report on the cause and effect of any one pollution in your locality. Mention the remedies to reduce the effects.		
	2	Discuss the recent climatic conditions of Kerala.		
	3	Present case studies of environmental movements in India as a group activity.		
	4	Discussion on environmental protection acts in India.		

	5	Discuss alternative energy sources to meet world's growing energy demands.		
5	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture method, Case Study Method, Assignment, Interactive Session, Group discussion
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory:25 marks** **Formative assessment** ● Quiz ● Assignments ● Seminar **Summative assessment** ● MCQ Exams
	B. Semester End examination (Theory based Examination) **Total:50 marks, duration 2 hrs** Multiple Choice Questions (25*2=50)

Textbooks

1. Odum, Eugene Pleasants, and Gary W. Barrett. *Fundamentals of ecology*. Vol. 3. Philadelphia: Saunders, 1971.
2. Bharucha Erach, Text Book of Environmental Studies for undergraduate Courses. University Press, IInd Edition 2013 (TB)
3. Pepper, Ian, Charles P. Gerba, and Mark L. Brusseau. *Environmental and pollution science*. Elsevier, 2011.

References

1. Singh, J. S., S. P. Singh, and S. R. Gupta. *Ecology, environmental science & conservation*. S. Chand Publishing, 2014.
2. Sodhi, Navjot S., L. G. Gibson, and Peter H. Raven. *Conservation Biology: Voices from the Tropics*. Wiley Blackwell, 2013.

SEMESTER 5

St Thomas College Palai Autonomous

<table>
<tr><td>Programme</td><td colspan="6">BSc (Hons) Physics</td></tr>
<tr><td>Course Name</td><td colspan="6">Classical Mechanics</td></tr>
<tr><td>Type of Course</td><td colspan="6">DSC A</td></tr>
<tr><td>Course Code</td><td colspan="6">24U5PHYDSC300</td></tr>
<tr><td>Course Level</td><td colspan="6">300</td></tr>
<tr><td>Course Summary</td><td colspan="6">This course provides an overview of the fundamental concepts of Lagrangian and Hamiltonian formalisms, equipping students with the skills to analyze dynamic systems. Emphasis is placed on applying Lagrangian and Hamiltonian approaches to address various dynamical scenarios. The course also delves into the foundational principles of the Special theory of relativity</td></tr>
<tr><td>Semester</td><td>5</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>4</td><td>0</td><td>0</td><td>0</td><td>60</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">Basic ideas of Newtonian Mechanics</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	To illustrate the dynamics of mechanical systems using Lagrangian formalism	A, An	1, 2
2	To solve the dynamics of simple mechanical systems using Lagrangian formalism	U, A	1, 2
3	To make use of the central force problem in different dynamical systems	U, An, A	1, 2
4	To illustrate the dynamics of mechanical systems using Hamiltonian formalism	U, A, An	1, 2

5	To solve the dynamics of simple mechanical systems using Hamiltonian formalism	U, A	1, 2
6	To interpret the concepts of Special theory of relativity	U, An	1, 2
7	To explain different physical phenomena using Special theory of relativity	U, A	1, 2

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom Transaction (Units)

Module	**Units**	**Course description**	**Hrs**	**CO No.**
1	**Lagrangian Formalism**		**15**	
	1.1	Constraints, and its classification -Degrees of Freedom, Generalized coordinates, Configuration space	3	1
	1.2	Virtual displacement, Principle of virtual work, D' Alembert's principle, Lagrange's equations of motion for conservative systems.	4	1
	1.3	Conjugate momenta and Cyclic coordinates. Conservation laws and Symmetry Properties, Noether's Theorem	4	1
	1.4	Application of Lagrange's equations of motion to mechanical systems, Linear Harmonic Oscillator, Simple Pendulum. Comparison of Newtonian and Lagrangian formulation.	4	2
2	**Two body central force problem**		**13**	
	2.1	Reduction of two Body central force problem to equivalent one body problem	3	3
	2.2	Equation of motion under central force, differential equation for an orbit	3	3
	2.3	Stability and closure of orbit under central force (Classification of orbits)	4	3
	2.4	Deduction of Kepler's law, Law of gravitation from Kepler's law	3	3

3	**Hamiltonian Formalism**		**15**	
	3.1	Hamilton's Variational principle - principle of least action - examples (Shortest distance between two points 2d, Brachistochrone problem)	4	4
	3.2	Lagrange's equation from variational principle, Hamilton's Canonical equations of motion,	3	4
	3.3	Hamilton's equations from Variational principle, Comparison of Newtonian and Lagrangian and Hamiltonian formulation.	4	4
	3.4	Application of Hamiltonian method to mechanical systems, Linear Harmonic oscillator, Simple Pendulum Planetary motion.	4	5
4	**Relativity**		**17**	
	4.1	Classical Relativity(Galilean Relativity) Galilean transformation, Galilean Invariance, Limitations	3	6
	4.2	Michelson-Morley experiment, Postulates of Special Theory of Relativity, Lorentz transformation	4	6
	4.3	Implications of Lorentz transformations, Spatial contraction-reciprocity, Time dilation, twin paradox, the composition of velocities, mass of moving particles.	5	6
	4.4	Equivalence of mass and energy. Reference to binding energy, Nuclear Fission and Fusion and pair production, Energy momentum Relation.	5	7
5	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecturing, Problem Solving, Simulations
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 marks**

	Formative assessment ● Quiz ● Assignments ● Seminar Summative assessment ● Written tests
	B. End Semester Examination (ESE) **Total: 70 marks, duration 2 hrs** ● Short answer type questions: Answer any 10 questions out of 12(10*3=30) ● Short essay type questions: Answer any 4 questions out of 6(4*7=28) ● Essay type questions: Answer any 1 question out of 2(1*12=12)

Textbook

1. Goldstein, Herbert, Poole Charles P., Safko John, Classical Mechanics, 3rd Edition, 2011.
2. Beiser, Arthur, Mahajan. Shobhit, Choudhury, S. Rai. Concepts of modern physics. McGraw Hill Education, 2017 7th Edition

References

1. Scheck Florian, Mechanics: From Newton's Laws to Deterministic Chaos, 4th Edition 2010.
2. Aruldhas G., Classical Mechanics, PHI 2008.
3. Morin David, Introduction to Classical Mechanics, Cambridge University Press, 2009.
4. Krane, Kenneth S. Modern physics. John Wiley & Sons, 2019

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<table>
<tr><td>Programme</td><td colspan="6">BSc (Hons) Physics</td></tr>
<tr><td>Course Name</td><td colspan="6">Introduction to Quantum Mechanics</td></tr>
<tr><td>Type of Course</td><td colspan="6">DSC A</td></tr>
<tr><td>Course Code</td><td colspan="6">24U5PHYDSC301</td></tr>
<tr><td>Course Level</td><td colspan="6">300</td></tr>
<tr><td>Course Summary</td><td colspan="6">At the introductory level, this course in quantum mechanics invites the student to experience the thrill of learning the counter intuitive ways of the quantum world. Basic machinery of quantum mechanics is introduced with one dimensional example. Hilbert space formalism and interpretations are discussed in a way that enables the student to study further ahead. The approach in the course is to learn the subject through solving problems and, therefore, requires the evaluation to be problem based.</td></tr>
<tr><td>Semester</td><td>5</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>4</td><td>0</td><td>0</td><td>0</td><td>60</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">Basic knowledge of Quantum Mechanics</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Train the student with techniques of quantum mechanics	U, A	1, 2
2	To realize the implications of quantum physics	A, An	1, 2
3	To build a quantum mechanical intuition	U, A, S	1, 2
4	To enable the pursuit of both foundational and advanced aspects of quantum physics	U	1, 2

**Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Content for Classroom Transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Quantum Behavior**		**15**	
	1.1	Young's double slit experiment - with bullets, waves and electrons. Interference of electron waves and watching electrons. First principles of quantum mechanics. (Reference 1, chapter 1)	6	1
	1.2	The Schrodinger Equation	2	1
	1.3	The Statistical Interpretation, Probability, Normalization	3	1,2
	1.4	Momentum, Uncertainty principle	4	1,2
2	**The Time-Independent Schrodinger Equation**		**15**	
	2.1	The Stationary States - Time Evaluation of Quantum Mechanics	3	2,3
	2.2	Infinite Square Well	3	2,3
	2.3	Harmonic Oscillator - Algebraic method.	3	2,3
	2.4	Free Particle	3	2,3
	2.5	Step potential (Problem)	3	2,3
3	**Vector spaces**		**15**	
	3.1	Vectors, Inner Products	4	4
	3.2	Functions as Vectors	2	4
	3.3	Linear Transformations	3	4
	3.4	Eigenvectors and Eigenvalues	3	4
	3.5	Hermitian Transformations	3	4
4	**Hilbert spaces and Interpretation**		**15**	
	4.1	Operators as Linear Transformations	4	4
	4.2	Hilbert Space	4	4
	4.3	Generalized Statistical Interpretation	3	4

	4.4	Generalized uncertainty principle: Proof, Minimum uncertainty wave packet.	4	4
5	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Tutorials, Seminars/ Presentations Activities, Practical sessions
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 marks** **Formative assessment** ● Quiz ● Assignments ● Seminar **Summative assessment** ● Written tests
	B. Semester End examination (Theory based Examination) **Total: 70 marks, duration 2 hrs** ● Short answer type questions: Answer any 10 questions out of 12(10*3=30) ● Short essay type questions: Answer any 4 questions out of 6(4*7=28) ● Essay type questions: Answer any 1 question out of 2(1*12=12)
Activities	Problem 1.17, 2.11,2.37,3.13,3.14 and 3.30 of textbook 2

Textbooks

1. Richard P. Feynman, Feynman Lectures on Physics Vol. III, Pearson (2012).
2. D. J. Griffiths, ``Introduction to Quantum Mechanics”, Second Edition, Prentice Hall (1995)

References

1. Shankar R. Fundamentals of Physics II – Electromagnetism, Optics, and Quantum Mechanics: (The Open Yale Courses Series) Yale University Press 2019.

St Thomas College Palai Autonomous

Programme	**BSc (Hons) Physics**					
Course Name	**Atomic and Molecular Physics**					
Type of Course	**DSC A**					
Course Code	**24U5PHYDSC302**					
Course Level	**300**					
Course Summary	This course provides a comprehensive view of the principles, techniques, and applications of Atomic and Molecular Spectroscopy. Students will gain an in-depth knowledge of the interactions between matter and electromagnetic radiation, focusing on the electronic, vibrational, and rotational transitions within atoms and molecules.					
Semester	5	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	**0**	**0**	**0**	**60**
Pre-requisites, if any	Basic understanding of Quantum Physics					

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains***	**PO**
1	To explain the evolution of classical and modern atom models, tracing the historical development from the Bohr atom model to the quantum mechanical model.	U	1,2
2	To make use of the concept of quantum numbers in describing the electron states in atoms	U, A	1,2
3	To implement quantum mechanical principles in electronic, vibrational, and rotational transitions, for explaining the spectroscopic data	U, A	1,2

4	Analyse different spectra, identify patterns, and draw meaningful conclusions from experimental data and thus cultivate critical thinking skill	An	1,2
5	Explain the principles of various spectroscopic techniques, including UV-Visible, Infrared (IR), Raman, NMR, and ESR spectroscopy.	U	1,2
6	Appreciate the diverse practical uses of different spectroscopic methods in real-world situations.	Ap	1,2
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom Transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Atomic Spectroscopy**		**20**	
	1.1	Absorption and emission spectra, Review of Atomic Physics, Bohr atom model – energy levels and Hydrogen spectra, Limitations of Bohr Model	5	1
	1.2	Stern- Gerlach experiment, Space quantization, Electron Spin, Quantum states of an electron in an atom, Quantum numbers, Exclusion principle, Orbital and Spin Angular momentum, Magnetic moments, Vector atom model	6	1, 2, 3
	1.3	Spectral terms and selection rules, LS and j-j coupling, Fine structure of Sodium D lines	4	1, 2, 3
	1.4	Zeeman effect, Quantum mechanical explanation for Normal and Anomalous Zeeman effect, Lande g-factor.	5	2, 3, 4
2	**Molecular Spectroscopy I**		**10**	
	2.1	Regions of Electromagnetic Spectrum, Microwave spectroscopy- Classification of molecules based on moment of inertia, Rigid diatomic molecules, rotational energy levels. Instrumentation and Applications	5	4, 5, 6
	2.2	Infrared spectroscopy- Vibrational energy of diatomic molecules, Harmonic oscillator, vibrational energy levels,	5	4, 5,

		Instrumentation and Applications		6
3	**Molecular Spectroscopy II**		**10**	
	3.1	Raman Scattering- Classical and Quantum theory of Raman Effect, Stokes and anti- stokes lines Mutual exclusion of IR and Raman spectra. Instrumentation and Applications.	5	4, 5, 6
	3.2	Electronic transitions- UV and Visible spectra, Beer Lambert law, Fluorescence and Phosphorescence	5	4, 5, 6
4	**Resonance Spectroscopy and Analysis**		**20**	
	4.1	NMR Spectroscopy- Basic principles, Resonance condition, Chemical shift, Instrumentation, Applications of NMR-MRI	6	4, 5, 6
	4.2	ESR Spectroscopy- Basic Principles and Instrumentation	4	4, 5, 6
	4.3	Mossbauer Spectroscopy - Basic Principle and Experimental Techniques and Applications	4	4,5,6
	4.4	1. GAMESS/ Gaussview software- (a) View molecular vibrations (b) Demonstration of IR, Raman, and UV spectra 2. Using simulation software (Gamess/Gaussview and Gaussian), visualise the optimized structure of H_2O and CO_2 molecule. Visualise the normal modes of vibrations. Identify the type of vibrations (symmetric stretching, asymmetric stretching, bending etc). 3. Analyse IR/Raman/UV spectra and interpret the results to extract information about the molecule/material. 4. Using a (Quantum chemical) computational software compare the IR and Raman spectra of H_2O and CO_2 molecules. 5. Using a (Quantum chemical) computational software, obtain the vibrational frequencies, bond length, bond angle, dipole moment & Total energy of H_2O and CO_2 molecules.	6	3,5,6
5	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Tutorials, Seminars/ Presentations Activities, Practical sessions
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 marks** **Formative assessment** ● Quiz ● Assignments ● Seminar **Summative assessment** ● Written tests
	B. End Semester Examination (ESE) **Total: 70 marks, duration 2 hrs** ● Short answer type questions: Answer any 10 questions out of 12(10*3=30) ● Short essay type questions: Answer any 4 questions out of 6(4*7=28) ● Essay type questions: Answer any 1 question out of 2(1*12=12)

Textbooks

1. Beiser, Arthur, Mahajan. Shobhit, Choudhury, S. Rai. Concepts of modern physics. McGraw Hill Education, 2017 7th Edition
2. Banwell C.N., McCash E. M. Fundamentals of Molecular Spectroscopy, McGraw Hill, 4th Edition, 2017
3. Aruldhas, G. Molecular Structure and Spectroscopy. PHI Learning Pvt. Ltd., 2nd Edition, 2007.

References

1. Murugeshan, R., and Sivaprasath Kiruthiga. Modern physics. S. Chand Publishing, 2016.
2. White, Harvey Elliott. "Introduction to atomic spectra." International Series in Pure and Applied Physics (1934).
3. Straughan B. P., Walker S. (Editors), Spectroscopy: –(Vol.1) John Wiley 1976
4. Feynman, Richard Phillips. The Feynman lectures on physics. 1 1963.

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Programme	**BSc (Hons) Physics**					
Course Name	**Semiconductor Optoelectronic devices**					
Type of Course	**DSE**					
Course Code	**24U5PHYDSE300**					
Course Level	**300**					
Course Summary	The course aims to develop an understanding of the physics of optoelectronic semiconductor devices such as LED, Lasers, optical modulators and switches.					
Semester	**5**	Credits			**4**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	**0**	**1**	**0**	**75**
Pre-requisites, if any	Basic Solid State Physics					

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	To explain the optical process in semiconductors.	K, U	1, 2
2	To appreciate the working mechanism of LEDs	U, Ap	1, 2
3	To analyse the basic concepts of heterojunction lasers	U, A, An	1, 2
4	To analyse the fundamental concepts of optoelectronic modulation and switching.	U, A, An	1, 2
5	To develop practical knowledge and an understanding of the trade-offs when using the optoelectronic devices in their respective applications.	U,A,An,S	1,2
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Optical Process in semiconductors**		**15**	
1	1.1	Electron -Hole pair formation and recombination.	**3**	1
	1.2	Absorption in semiconductors.	5	1
	1.3	Radiation in semiconductors.	4	1
	1.4	Absorption and luminescence in quantum wells.	3	1
2	**LED and LASERS**		**16**	
	2.1	Electroluminescent process, Choice of LED material, Light output from LED.	3	2
	2.2	Heterojunction LED. Device performance Characteristics.	5	2
	2.3	Heterojunction Lasers	4	3
	2.4	Quantum Well Lasers	4	3
3	**Optoelectronic modulation and switching devices**		**14**	
	3.1	Introduction, Analog and digital modulation. Quantum well electro-absorption modulators.	4	4
	3.2	Electro Optic Modulators: Birefringence. Electrooptic effect phase and amplitude modulation.	7	4
	3.3	Optical switching introduction and self electro optic devices.	3	4
4	**Practicals**		**30**	
	4.1	Study the V-I characteristics of LEDs emitting different wavelengths and compare their turn-on voltages.		
	4.2	Determination of Plank’s constant using LED.		

	4.3	Design a LED driver circuit employing a constant current source using an opamp and transistor and study its performance.		
	4.4	Determine the diameter of a thin wire using laser.		
	4.5	Measure the divergence of an edge emitting diode laser beam by measuring the dimensions of the beam projected on to a screen at different distances.		
	4.6	To measure the diameter (beam spot size) of the laser beam		
	4.7	To demonstrate optical modulation in a simple fiber optic communication link.		
	4.8	To study the modulation characteristics of a Light Emitting Diode (LED).		
	4.9	From the given absorption/transmission data obtain the bandgap of a semiconductor.		
	4.10	From the given absorption/transmission data obtain the absorption coefficient of a semiconductor.		
5	**Teacher Specific Content**			

Teaching and Learning Approach	Classroom Procedure (Mode of transaction) Lecture, use of demonstrations and animations/videos
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 marks** **Formative assessment** ● Quiz ● Assignment ● Seminar **Summative assessment** ● Written test

	Practical:15 marks ● Lab involvement ● Viva
	B. End Semester Examination (ESE) **Theory: 50 marks, duration 1.5 hrs** ● Short answer type questions: Answer any 7 questions out of 10(7*2=14) ● Short essay-type questions: Answer any 4 questions out of 6(4*6=24) ● Essay type questions: Answer any 1 question out of 2(1*12=12) **Practical: 35 marks, duration 2 hrs** ● Lab Exam:30 marks ● Record: 5 marks

Textbook

1. Bhattacharya Pallab, Semiconductor Optoelectronic Devices Pierson Education, Second Edition, 2nd Edition 2017.

References

1. Wilson John, Hawkes John, Optoelectronics: An Introduction Prentice Hall 2nd Edition 1989.
2. Kasap S.O., Optoelectronics and Photonics: Principles and Practices Pearson Education Ltd. 2nd Edition, 2012.
3. Sze, S. M., Lee M. K. Semiconductor Devices: Physics and Technology John Wiley and Sons 3rd Edition 2015.
4. Saleh B. E. A., M. C. Teich, Fundamentals of Photonics John Wiley and Sons 2nd Edition 2012.

St Thomas College Palai Autonomous

Programme	**BSc (Hons) Physics**					
Course Name	**Computational Physics: Python**					
Type of Course	**DSE**					
Course Code	**24U5PHYDSE301**					
Course Level	**300**					
Course Summary	To enable the student to master the Python basics, understand the Python programming tools and apply it to physical problems. Develop Python programs and debug for logical and syntax errors.					
Semester	5	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	**0**	**1**	**0**	**75**
Pre-requisites, if any	Nil					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	To understand the fundamental syntax and operations used in Python Programming	U	1,2, 3
2	To explain the concept of object-oriented programming the basic principles of classes and objects in Python.	U	1,2, 3
3	To solve simple computational problems using appropriate data structures and control flow in Python	A	1,2, 3

4	To Analyze and solve computational problems using different packages.	A,An,S	1,2, 3
5	To Analyze and optimize code for performance by employing profiling tools and identifying syntax, logical errors, and bottlenecks in Python programs.	A,An,S	1,2, 3
6	To evaluate and select appropriate data visualization techniques using libraries like Matplotlib and Seaborn for presenting data in Python.	An,E,S	1,2, 3
7	To evaluate the efficiency of different algorithms and make informed decisions about their implementation in Python.	An,E,S	1,2, 3
8	To design and develop Python programs that incorporate modular programming principles, using functions and libraries effectively.	C	1,2, 3
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Essentials & Operations**		**12**	
	1.1	Introduction to Algorithms, Flowcharts and Pseudocode.	3	1
	1.2	Variables, operators, expressions, Reading keyboard input print command, formatted printing, Data types, Strings, Arrays (from the array module) List, Tuples, Sets, Dictionaries	3	1, 2
	1.3	List operations (len, append, reverse, sort, max, min, count, sum), set operations (set, add, remove, in, not in).	3	1
	1.4	Tuples (max, min, sum, concatenate). Dictionaries operations (get, update, pop, keys)	3	1, 2
2	**Flow of Control**		**13**	

	2.1	if..else, if..elif, while, for, break, List comprehension	4	1,3
	2.2	Various control and looping statements: (if, if..else, if..elif, while, for, break, continue)	4	1,3
	2.3	User defined functions- File input and file output.	2	1
	2.4	Concepts of Object-oriented programming	3	2
3	**3.1: Packages: Math and CMath**		**7**	
	3.1.1	Fundamental Operations: Arithmetic operations (addition, subtraction, multiplication, division)	2	1, 4, 5
	3.1.2	Exponents and logarithms, Trigonometric functions, Advanced Concepts: Complex numbers, Mathematical constants.	3	1, 4, 5
	3.1.3	Complex Number Manipulation, Basic operations on complex numbers, Trigonometric and logarithmic functions for complex numbers	2	1, 4, 5
	3.2: Packages: NumPy		**7**	
	3.2.1	Introduction to NumPy: Arrays: creation, indexing, and slicing.	2	1, 4, 5
	3.2.2	Array operations: element-wise operations, Linear algebra operations with NumPy.	2	1, 4, 5
	3.2.3	Advanced NumPy Techniques: Random number generation, Universal functions (ufuncs).	3	1, 4, 5
	3.3: Matplotlib		**6**	
	3.3.1	Basic Plotting: Line plots, scatter plots, and bar plots, Customizing plot appearance.	2	1, 5, 6
	3.3.2	Advanced Visualization: Subplots and multiple plots, 3D plotting, Plotting with external datasets,	2	1, 5, 6

	3.3.3	Data Visualization Best Practices: Choosing the right plot for the data, Adding labels, titles, and legends, Enhancing clarity with colours and styles	2	1, 5, 6
4	**Practicals** (Do not use any built-in packages for doing the problem)		**30**	1, 5,7, 8
	4.1	Determine the accuracy and processing time for different step sizes by solving algebraic equations using the Bisection and Newton-Raphson methods. Then, plot the error vs step size.		
	4.2	Solve the differential equation of a simple pendulum numerically (using the Euler and Runge-Kutta techniques), compare the result with analytical solutions, and plot the results for various initial conditions.		
	4.3	Use the Trapezoidal Rule, Simpson's 1/3-Rule, and Simpson's 3/8-Rule to fine-tune the definite integral of a given function. Then, compare the accuracy to the analytical solution. Plot the error vs. step size while repeating the experiment with various step sizes.		
	4.4	Find the maximum height of a projectile, its horizontal range, and its time of flight for varying initial velocities and projection angles.		
	4.5	Examine how the diffraction pattern varies with the slit width and wavelength of a monochromatic light source while examining diffraction patterns caused by a single slit.		
	4.6	Plot the intensity pattern for the Fresnel and Fraunhofer diffraction of monochromatic light by a single slit for different slit widths and screen distances.		

	4.7	Trace the 3-dimensional trajectory of an electron travelling in a homogeneous perpendicular electric and magnetic field		
	4.8	Examine the trajectory and phase space trajectory of a damped harmonic oscillator for various damping coefficients, (solve the differential equation numerically) and compare it with the analytical solutions.		
	4.9	Using two oscillatory functions of varying frequency and amplitude, illustrate various kinds of Lissajous figures.		
	4.10	Using the Monte Carlo method obtain the value of $\pi(pi)$.		
	4.11	Using Monte Carlo technique, calculate the value of the given integral. Compare your result with the value obtained by analytical method.		
	4.12	Solve radioactive decay law to plot the number of nuclei remaining without disintegration(N) after a time t for a sample of known decay constant. From this evaluate the activity of the given sample. or similar codes suggested by the instructor		
5	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Hands on training, Presentations, Discussions
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 marks** **Formative assessment** ● Quiz ● Assignment ● Seminar **Summative assessment**

	● Written test **Practical:15 marks** ● Lab involvement ● Viva
	B. Semester End Examination **Theory: 50 marks, duration 1.5 hrs** ● Short answer type questions: Answer any 7 questions out of 10(7*2=14) ● Short essay-type questions: Answer any 4 questions out of 6(4*6=24) ● Essay type questions: Answer any 1 question out of 2(1*12=12) **Practical: 35 marks, duration 2 hrs** ● Lab Exam:30 marks ● Record: 5 marks

Textbooks

1. Downey, Allen B. *How to think like a computer scientist*. Green Tea Press 2003.

References

1. Mahendra Verma, Practical Numerical Computing Using Python: Scientific & Engineering Applications, Amazon Digital Services LLC.
2. Programming for Computations - Python, Svein Linge, Hans Petter Langtangen, SpringerOpen 2016. [free ebook].
3. Lambert, Kenneth A. *Fundamentals of Python: first programs*. Cengage Learning, 2018.

St Thomas College Palai Autonomous

<table>
<tr><td>Programme</td><td colspan="6">BSc (Hons) Physics</td></tr>
<tr><td>Course Name</td><td colspan="6">Physics of Atmosphere</td></tr>
<tr><td>Type of Course</td><td colspan="6">DSE</td></tr>
<tr><td>Course Code</td><td colspan="6">24U5PHYDSE302</td></tr>
<tr><td>Course Level</td><td colspan="6">300</td></tr>
<tr><td>Course Summary</td><td colspan="6">This course provides a foundational understanding of the Earth's atmosphere, covering key aspects such as its composition, vertical structure, winds, precipitation, and hydrologic cycles. Students learn fundamental concepts like virtual temperature, lapse rates, and moisture parameters, enabling them to analyze atmospheric behaviors. The course encourages critical thinking by exploring radiation, energy balance, dynamics of horizontal flows, and forces affecting winds. Additionally, it facilitates synthesis of knowledge by studying planetary impact on general atmospheric circulation. Students also gain insights into climate-related concepts including variability, greenhouse gases, feedback, and methods for monitoring and predicting climate change.</td></tr>
<tr><td>Semester</td><td>5</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>3</td><td>0</td><td>1</td><td>0</td><td>75</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">Mechanics, Mathematics (calculus, algebra and differential equations)</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**

1	Students will demonstrate a comprehensive understanding of fundamental atmospheric concepts including mass, chemical composition, vertical structure, wind-pressure relationships, smaller-scale motions, and the hydrologic cycle, enabling them to describe and explain these phenomena accurately.	K, U	1,2
2	Students will apply their understanding of thermodynamic principles, such as virtual temperature, hydrostatic equation, geopotential, and moisture parameters, to analyze air parcel behaviour, lapse rates, potential temperature, and moisture content in various atmospheric conditions.	U, A, An	2,3,4
3	Students will understand the effects of radiation laws (Planck's function, Wein's displacement law, Stefan-Boltzman law, Kirchoff's law), the greenhouse effect, atmospheric scattering, and Beer's law, and apply them to predict and assess radiation balance at the top of the atmosphere.	U, A, An	2,3,4
4	Students will demonstrate proficiency in analyzing vorticity, divergence, horizontal flow dynamics, and forces influencing atmospheric circulation, including geostrophic, gradient, and thermal winds, thereby enabling them to interpret the impacts of planetary rotation on atmospheric motions and wave generation.	U, A, An	2,3,4
5	Students will synthesize their understanding of present-day climate conditions, seasonal variations, and climate variability (internal, coupled, and external), incorporating climate feedback mechanisms, greenhouse gas accumulation, and techniques for climate monitoring and prediction into comprehensive analyses.	An, E	4,5
6	Students will critically analyze and apply their knowledge of atmospheric general circulation, pressure as a vertical coordinate, hydrostatic balance, and inference of vertical motion fields, thereby constructing sophisticated interpretations of global weather patterns and climate systems.	An, E, C	4,5,6

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom Transaction (Units)

Module	**Units**	**Course description**	**Hrs**	**CO No.**
1	**Introduction**		**15**	
	1.1	A brief survey of the atmosphere-, mass, chemical composition, vertical structure, wind and pressure, observed surface wind field, precipitation- hydrologic cycle	5	1
	1.2	Virtual temperature, hydrostatic equation, geopotential, scale height, hypsometric equation	3	1
	1.3	Concept of air parcel, dry adiabatic lapse rate, potential temperature	2	1
	1.4	Weather and Climate, Present day climate-annual mean conditions and seasonal dependence, climate of India during the four seasons	3	5
	1.5	Climate indices, climate monitoring and prediction.	2	5
2	**Atmospheric Radiative Transfer**		**15**	
	2.1	Blackbody Radiation- Planck's function, Wein's displacement law, Stefan-Boltzmann law, Kirchoff's law	5	3
	2.2	Greenhouse effect, scattering by air molecules and particles, Beer's law, atmospheric window	5	3
	2.3	Radiation balance at the top of the atmosphere; Familiarisation with a radiative transfer model (eg. SBDART)	5	3
3	**Atmospheric dynamics**		**15**	
	3.1	Vorticity and Divergence, dynamics of horizontal flow- apparent forces, real forces.	4	4

	3.2	Horizontal equations of motion, Geostrophic wind, gradient wind, thermal wind	4	4
	3.3	Suppression of vertical motions by planetary rotation, potential vorticity, Rossby waves, atmospheric scales of motion	4	4
	3.4	Atmospheric general circulation, atmosphere as a heat engine	3	4, 5
4	**Practical**		**30**	
	1	Analyse the variation in ground level air temperature at a location over a period of time from an automatic weather station and estimate basic statistics.		1,4,5
	2	Analyse the variation in ground level humidity at a location over a period of time from an automatic weather station and estimate basic statistics.		1,4,5
	3	Analyse the variation in ground level wind speed and direction at a location over a period of time from an automatic weather station and estimate basic statistics.		1,4,5
	4	Analyse the variation in rainfall at a location over a period of time from an automatic weather station and estimate basic statistics.		1,4,5
	5	Analyze the air quality index at a location from the Central Pollution Control Board and monitor air quality over a period of time.		1,4,6
	6	Study and interpret meteorological charts (Identification of isobaric patterns, signs and symbols) from the India Meteorological Department (IMD).		3,4,6
	7	Analyze monsoon charts from the India Meteorological Department (IMD) and identify the features/trends.		1,4,5
	8	Using radiosonde data over any location analyse the vertical profile of temperature and estimate various geophysical parameters (tropopause height, boundary layer height, lapse rate) over a period of time.		3,4,6
	9	Using radiosonde data over any location analyse the vertical profile of humidity to identify the cloud layers for a period of time and compute their statistics		3,4,6
	10	Estimate convective available potential energy and convective inhibition and analyse for different events (clear days, cloud days, cyclone events etc.)		3,4,6

	11	Study and interpret Doppler weather radar graphs over any location from the India Meteorological Department (IMD).		3,6
	13	Analyze any five climate indices and interpret the observations.		5
	14	Plot the tracks of any five cyclone storms over Indian subcontinent (https://rsmcnewdelhi.imd.gov.in/report.php?internal_menu=MjY) and analyse the observations.		1,6
	15	Intercompare the rainfall data from numerical weather prediction models over the Indian region with satellite data.		1,6
	16	Measure atmospheric pressure using different instruments and analyze the data.		1,5
	17	Measure ground-level ozone concentration and analyze its variation.		1,5
	18	Measure the surface albedo at different locations and analyze its spatial variation.		2,5
	19	Analyze aerosol properties using available solar radiometer data		1,4,5
	20	Analyze aerosols using available satellite-based sensor data.		1,4,5
	21	Analyse the variation of surface temperature at different locations using infrared thermometer/ remote sensing technique.		1,6
	22	Measure the spectral response of various bodies using a spectrometer		2,6
	23	Examine the difference between radiation fluxes computed with and without aerosols using a radiative transfer model (eg SBDART)		2,5,6
	24	Investigate how surface irradiance depends on the combined effects of cloud optical depth and surface albedo using a radiative transfer model		2,5,6

	25	Compute the spectral surface irradiance in the thermal IR for three cases: clear skies, and high-altitude clouds of optical depth 1 and 5.		2,5,6
	26	Estimate the future change in any two atmospheric variables for a given warming scenario using IPCC WG1 Interactive Atlas Simple Climate Futures (https://interactive-atlas.ipcc.ch/)		3,5
5	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Discussions, Online simulations, Problem solving sessions
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 marks** **Formative assessment** ● Quiz ● Assignment ● Seminar **Summative assessment** ● Written test **Practical:15 marks** ● Lab involvement ● Viva
	B. End Semester Examination (ESE) **Theory: 50 marks, duration 2 hrs**

	● Short answer type questions: Answer any 7 questions out of 10(7*2=14) ● Short essay-type questions: Answer any 4 questions out of 6(4*6=24) ● Essay type questions: Answer any 1 question out of 2(1*12=12) **Practical: 35 marks, duration 2 hrs** ● Lab Exam:30 marks ● Record: 5 marks

Textbook

1. Wallace, John M., and Peter V. Hobbs. 2006. *Atmospheric Science: An Introductory Survey*. 2nd ed. Elsevier Inc.

References

1. Ahrens, Donald C. 2009. *Meteorology Today*. 9th edn. Brooks/Cole, Cengage Learning.
2. Holton, James R. 2004. *An Introduction to Dynamic Meteorology*. 4th ed. USA: Elsevier Academic Press.
3. Mcilveen, Robin. 1992. *Fundamentals of Weather and Climate*. 2nd ed. Spinger-Science+Business Media.

St Thomas College Palai Autonomous

Programme	**BSc (Hons) Physics**					
Course Name	**Laser, Non-linear Optics and Fiber Optics**					
Type of Course	**DSE**					
Course Code	**24U5PHYDSE303**					
Course Level	**300**					
Course Summary	Laser, Non-linear Optics and Fiber Optics aims to equip the students with the concepts of laser action and diverse laser systems, offering a concrete theoretical backdrop. The course unfolds the modes of laser operation, delves into the dynamics of nonlinear optics, and provides practical insights into the application of nonlinear effects and materials. This course also helps the students to explore the propagation of light through fibres and waveguides.					
Semester	5	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	**0**	**1**	**0**	**75**
Pre-requisites, if any	Fundamentals of Optics					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	To acquire knowledge on the laser action and different laser systems with relevant theoretical background	U	1, 2, 3
2	To describe the modes of laser operation and dynamics underlying the processes	U	1, 2, 3
3	To gain the theoretical foundations of nonlinear optics, as well as practical knowledge of nonlinear effects and nonlinear materials	U, A	1, 2, 3

4	To relate the concepts and methods of non-linear optics with its applications	U, A	1, 2, 3
5	To analyse the propagation of light through fibres and waveguides based on the non linear optical effects	U, An	1, 2
6	To examine the performance parameters of optical fibre and laser by using different optical techniques	A, An, S	1, 2, 3
7	To apply the concepts of diffraction, polarisation, and dispersion in different optical phenomena	A, An, S	1, 2, 3

****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***

COURSE CONTENT

Content for Classroom transaction (Units)

Module	**Units**	**Course description**	**Hrs**	**CO No.**
1	**Basic Principles of Lasers & Laser Systems**		**15**	
	1.1	Population Inversion, Laser Pumping – Two level system, Three level system, Resonators – Vibrational Modes of a resonator, Number of Modes per unit volume, Open Resonators, Confocal Resonators, Quality factor of a laser cavity, Losses inside the cavity, The Threshold Condition, Quantum Yield	8	1
	1.2	Solid state lasers- Ruby Laser, Gas Lasers- Helium-Neon laser, Semiconductor Laser-Central Features of Semiconductor Lasers, Intrinsic Semiconductor Lasers, Doped Semiconductors, Condition for Laser Action	7	1
2	**Dynamics of Laser Processes & Nonlinear Optics**		**15**	
	2.1	Production of Giant Pulse- Q, Methods of Q switching - Mechanical shutter, Electro optical shutters (Kerr and Pockels), Shutters using saturable dyes, Laser Amplifiers, Mode locking (Qualitative), Ultrashort light pulses	5	2

	2.2	Harmonic generation, Second Harmonic generation, Phase Matching, Third Harmonic generation, Optical Mixing, Parametric generation of light, Self-focusing of light, Multiphoton processes- Two photon and three photon processes (Qualitative Only)	10	3
3	**Fiber and Waveguide Optics**		**15**	
	3.1	Guided Waves, The slab dielectric guide, Evanescent fields in fibre optics, Cylindrical Fibers and waveguides	5	4,5
	3.2	Numerical Aperture, Materials for optical fibres	3	4,5
	3.3	Dispersion in optical fibres, Dispersion Compensation, Modulation and Communication	5	4,5
	3.4	Photonic crystal fibres, Optical fibre sensors (Qualitative only), Fabrication of Optical fibres	2	4,5
4	**Practicals**		**30**	
	4.1	Verification of Snell's law using a laser and a glass slab.		7
	4.2	Design and construct a laser beam expander and study its performance.		6
	4.3	Study the refraction of a laser beam in a glass slab and measure its refractive index using total internal reflection.		6
	4.4	Determination of wavelength of a laser using diffraction grating.		7
	4.5	Determine the diameter of a thin wire using laser.		7
	4.6	Fraunhoffer diffraction: Wavelength of a laser using a double slit.		7
	4.7	Determine the numerical aperture and acceptance angle of an optical fibre.		6
	4.8	Determine the refractive index of glass by measuring the Brewster angle using a laser beam.		7
	4.9	Measure the divergence of an edge emitting diode laser beam by measuring the dimensions of the beam projected on to a screen at different distances.		6

	4.10	To measure the diameter (beam spot size) of the laser beam		6
5	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, Use of demonstrations, activities and animations/videos
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 marks** **Formative assessment** ● Quiz ● Assignment ● Seminar **Summative assessment** ● Written test **Practical:15 marks** ● Lab involvement ● Viva
	B. Semester End Examination **Theory: 50 marks, duration 1.5 hrs** ● Short answer type questions: Answer any 7 questions out of 10 (7*2=14) ● Short essay-type questions: Answer any 4 questions out of 6(4*6=24) ● Essay type questions: Answer any 1 question out of 2(1*12=12) **Practical: 35 marks, duration 2 hrs** ● Lab Exam:30 marks ● Record: 5 marks

Textbooks

1. Laud, B. B., Lasers and Nonlinear Optics (New Age International- 3rd Edition), 2011 (For Module 1 and 2)
2. Smith F. Graham, King Terry A., Wilkins Dan Optics and Photonics: An Introduction John Wiley & Sons, 2 Edition, 2013 (For Module 3)

References

1. William T. Silfvast, Laser Fundamentals, Cambridge University Press 2nd Edition 2008.
2. Svelto Orazio, Principles of Lasers Springer 5th Edition 2016.
3. Boyd, Robert W. Nonlinear Optics, Academic Press, 3rd Edition 2008.
4. Thyagarajan, K., Ghatak Ajoy, Fiber Optic Essentials John Wiley & Sons. 1st Edition 2007.

St Thomas College Palai Autonomous

Programme	**BSc (Hons) Physics**					
Course Name	**Physics of Advanced Materials**					
Type of Course	**DSE**					
Course Code	**24U5PHYDSE304**					
Course Level	**300**					
Course Summary	This course provides the basic knowledge of Crystal Structure, Symmetry operation and different Crystallographic methods for determining crystal structure.					
Semester	5	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	1	0	75
Pre-requisites, if any	Basic knowledge of Physics and Mathematics					

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Understanding different types of materials	U	1
2	Explain the mechanical properties of different materials	U	1, 2
3	Analysing the electrical properties of materials	An	1, 2
4	Analysing the magnetic properties of materials	An	1
5	Analysing the thermal properties of materials	An	1, 2
6	Analysing the optical properties of materials	An	1,2
7	Application of the various properties of materials.	A	1, 2
***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)**			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	**Units**	**Course description**	**Hrs**	**CO No.**
1	**Advanced Materials**		**15**	
	1.1	**Ceramics:** Glass, Glass Ceramics, Clay products, Refractories, Abrasives, Cements and Advanced Ceramics. Mechanical Properties: Brittle Fracture of Ceramics, Stress Strain Behaviour.	5	**1,2**
	1.2	**Polymers:** Plastics, Elastomers, Fibers, Advanced Polymeric Materials. Mechanical behaviour of Polymers: Stress Strain Behaviour, Macroscopic deformation, Viscoelastic deformation, Fracture of Polymers.	5	**1,2**
	1.3	**Composities:** Particle Reinforced composites: Large particle composite, Dispersion strengthened composites.	5	**1**
2	**Electrical Properties of Materials**		**15**	
	2.1	**Metals:** Electrical Conductivity, Electron Mobility, Electrical resistivity of metals.	4	**3**
	2.2	**Semiconductors:** Temperature dependence of carrier concentration, Factors affecting carrier mobility, Hall effect	5	**3**
	2.3	**Polymers and dielectrics:** Electrical properties of polymers. Capacitance, Field Vectors and polarisation, Types of polarisation.	4	**3**
	2.4	Ferroelectricity, Piezoelectricity (Qualitative ideas)	2	**1**
3	**Magnetic, Thermal and Optic properties of materials**		**15**	
	3.1	**Magnetic:** Influence of temperature on Magnetic behaviour. Domains and Hysteresis, Soft and Hard Magnetic Materials.	5	**4**
	3.2	**Thermal:** Heat Capacity, Thermal expansion, Thermal conductivity.	5	**5**
	3.3	**Optical:** Optical properties in metals, Optical Properties of non metals.	5	**6**

4	**Practicals**		**30**	7
	1.	Thermal analysis of materials from experimental data		
	2.	Comparison of resistance variation of a carbon film resistor, metal wire, semiconductor and thermistor with temperature		
	3.	Band gap and type of optical transition (direct or Indirect using Tauc relation) from absorption spectra from given data		
	4.	Absorption coefficient of solution- path length and concentration dependence		
	5.	Optical activity- specific rotation measurement		
	6.	Frequency dependence of dielectric constant.		
	7.	Temperature dependence of dielectric constant.		
5	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Presentations, Discussions
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 marks** **Formative assessment** ● Quiz ● Assignment ● Seminar **Summative assessment** ● Written test **Practical:15 marks** ● Lab involvement ● Viva

	B. End Semester Examination (ESE) **Theory: 50 marks, duration 1.5 hrs** ● Short answer type questions: Answer any 7 questions out of 10(7*2=14) ● Short essay-type questions: Answer any 4 questions out of 6(4*6=24) ● Essay type questions: Answer any 1 question out of 2(1*12=12) **Practical: 35 marks, duration 2 hrs** ● Lab Exam:30 marks ● Record: 5 marks

Textbooks

1. Callister Jr, W. D., and Rethwisch D. G. Callister's materials science and engineering. John Wiley & Sons, Ninth edition, 2014.
2. Raghavan, V., Materials Science and Engineering: A first course. PHI Learning Pvt. Ltd., Sixth edition, 2015.

References

1. Ali Omar, M. Elementary solid-state physics: principles and applications. Pearson Education India, First Edition 2001.
2. McKelvey John Philip, Solid State Physics for Engineering and Materials Science, Krieger Publishing Company 1993.

St Thomas College Palai Autonomous

Programme	**BSc (Hons) Physics**					
Course Name	**Introduction to Group theory**					
Type of Course	**DSE**					
Course Code	**24U5PHYDSE305**					
Course Level	**300**					
Course Summary	Group theory is introduced to students of physics, chemistry and other disciplines enabling them use its techniques to analyze physical problems with symmetry. Both discrete groups and Lie groups are introduced along with basics of theory of their representations.					
Semester	5	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	**0**	**1**	**0**	**75**
Pre-requisites, if any	Nil					

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Learn the algebra of groups	U, An, E	1, 2
2	Recognize important discrete groups in problems	An, E	1, 2
3	Identify irreducible representations	An, E	1, 2
4	Learn the essentials of Lie groups and their algebra	U, An, E, C	1, 2
5	Identify the representations of Lie groups	An, E	1,2
***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)**			

COURSE CONTENT

Content for Classroom Transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Elements of groups**		18	
	1.1	Correspondences and transformations	1	1
	1.2	Groups. Definitions and examples	2	1
	1.3	Subgroups. Cayley's theorem	2	1
	1.4	Cosets. Lagrange's theorem, Conjugate classes	2	1
	1.5	Invariant subgroups. Factor groups. Homomorphism	2	1
	1.6	Direct products	2	1
	1.7	**Practicum** (Problems)	7	1
2	**Point groups, Group Representations**		18	
	2.1	Point groups: Symmetry elements. Pole figures	2	2
	2.2	Equivalent axes and planes. Two-sided axes	1	2
	2.3	Groups whose elements are pure rotations: uniaxial groups, dihedral groups	2	2
	2.4	Groups whose elements are pure rotations. Regular polyhedra	2	2
	2.5	Symmetry groups containing rotation reflections. Adjunction of reflections to the groups Dn.	2	2
	2.6	The complete symmetry groups of the regular polyhedra	2	2
	2.7	**Practicum** (Problems)	7	2
3	**Representations, Characters, Irreducibility**		20	
	3.1	Group representations	2	3

	3.2	Equivalent representations; characters	2	3
	3.3	Analysis of representations; reducibility; irreducible representations	2	3
	3.4	Schur's lemmas, The orthogonality relations	2	3
	3.5	Criteria for irreducibility. Analysis of representations	2	3
	3.6	The general theorems. Group algebra	2	3
	3.7	**Practicum** (Problems)	8	3
4	**Lie groups and Lie algebra**		**19**	
	4.1	Summary of results for finite groups	2	4
	4.2	Continuous groups. Lie groups, Examples of Lie groups	2	4
	4.3	One-parameter groups. Infinitesimal transformations	2	4
	4.4	Lie groups and Lie algebra	2	4,5
	4.5	SU(2)	3	4,5
	4.6	**Practicum** (Problems)	8	4,5

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Tutorials, Seminars/ Presentations Activities, Practical sessions
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 marks**

	Formative assessment ● Quiz ● Two Assignments ● Seminar ● Worksheets **Summative assessment** ● Written tests
	B. Semester End examination **Theory: 70 marks** Written exam – 2hrs ● Short answer type questions: Answer any 7 questions out of 10(7*2=14) ● Short essay-type questions: Answer any 4 questions out of 6(4*6=24) ● Problem type questions: Answer any 4 questions out of 7(4*5=20) ● Essay type questions: Answer any 1 question out of 2(1*12=12)

Textbooks

1. Group theory and its applications to physical problems, M Hamermesh
2. Semi-simple Lie algebras and their representations, Robert N Cahn

References

1. Lie algebras in particle physics, H Georgi
2. Elements of Group theory for Physicists, A W Joshi

St Thomas College Palai Autonomous

Programme	**BSc (Honours) Physics**					
Course Name	**Robotics and Industrial Automation**					
Type of Course	**DSE**					
Course Code	**24U5PHYDSE310**					
Course Level	**300**					
Course Summary and Justification	This course provides learners with a comprehensive understanding of industrial automation, covering key components, PLC programming, robotic systems, and hands-on skills in designing automated systems.					
Semester	5	Credits			4	**Total Hours**
Course Details	**Learning Approach**	**Lecture**	**Tutorial**	**Practical**	**Others**	
		3	0	1	0	75
Pre-requisites	Knowledge in Basic Electronics					

COURSE OUTCOMES (CO)

CO No:	**Expected Course Outcome**	**Learning Domains***	**PO No:**
1	Explain the principles and applications of Robotics and Industrial Automation	U	1,2
2	Apply automation techniques using PLC	A	1,2
3	Analyze and troubleshoot automation systems in real-world scenarios	An	1,2,10
4	Design and develop automated solutions for specific tasks	C	1,2,10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	**Unit**	**Course description**	**Hours**	**CO No:**
1	1.1	Introduction to Robotics and its Evolution	2	1
	1.2	Industrial automation- Definition, Purpose, Different types, Industry Standard- Industry 4.0	2	1
	1.3	Sensors - Basic concepts of piezoelectric sensor, IR proximity sensor. PIR Sensor	6	1
	1.4	Motors - Basic concepts of Servo Motors, geared DC motors and stepper Motors. Actuators - Basic concepts	5	1

		of Electrical Actuators		
2	2.1	Different types of PLCs, Basic programming, basics of Ladder Logic	5	2
	2.2	Introduction to PLC -Inputs and Outputs, Types of I/O Modules	4	2
	2.3	PLC interfacing with LED and Motor	2	2
	2.4	PLC interfacing with Temperature, humidity Gas and PIR Sensors	4	2
3	3.1	Control systems and their role in robotics, Example of closed loop control system - Automatic water level system	5	3
	3.2	Components of an Automatic conveyor belt mechanism	4	3
	3.3	Robotics in industry- pick and place, spot welding	6	3
4		**Practical / Simulation** (OpenPLC Editor, TRiLOGI, WPL Soft, Do-more Designer, plc simulator online or any other). **Minimum 6 experiments** 1. Basic ON/OFF Control: Use a switch to control an output (e.g., a lamp) using PLC. 2. Toggle Operation: Implement a toggle switch to alternate between two outputs. 3. Timer Functionality: Use timers to control the ON/OFF duration of an output. 4. Latching Circuit: Create a latch/unlatch mechanism to maintain output state. 5. Logic Gates Implementation: Use PLC programming to simulate AND, OR, NOT logic functions. 6. Motor Control: Control the direction and speed of a motor using PLC. 7. Traffic Light Simulation: Simulate a traffic light system with different timing sequences. 8. Temperature Control: Control a heating or cooling system based on temperature sensor inputs. 9. Water Level Monitoring: Use sensors to monitor and control water levels in a tank. 10. Conveyor Belt Control: Control the operation and speed of a conveyor belt using PLC. 11. Alarm System: Create an alarm system based on sensor inputs or specific conditions.	30	3, 4

		12. Robotic Arm Control: Basic control of a robotic arm using PLC 13. Robotic Application: Robotic arm pick-and-place tasks using PLC		
5		**Teacher Specific Content**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Leverage a blended learning approach with a mix of lectures, interactive discussions, and hands-on lab sessions
Assessment Types	**MODE OF ASSESSMENT (Internal)** **A. Continuous Comprehensive Assessment (CCA)** **Theory: - 25 Marks** 1. Internal Test – One MCQ based and one extended answer type 2. Seminar Presentation – a real time application of emerging technology to be identified and present it as seminar **Practical : 15 Marks** Components for assessment (suggestions): A combination of quizzes, assignments, Performance, Case study **B. Semester End examination (External Evaluation)** 1.Written Test (50 marks)**, duration 1.5 hrs** a. MCQ - 10 Marks b. Short answer questions (4 out of 6 questions)-4x5=20 marks c. Essay questions -2 out of 4 - 2x10=20 marks 2. Practical Exam (35 marks)**, duration 2 hrs** a. Viva b. Lab report c. Demonstration

References

1. Merat, Frank. "Introduction to robotics: Mechanics and control." IEEE Journal on Robotics and Automation 3.2 (1987): 166-166.
2. Chakraborty, Kunal, Palash De, and Indranil Roy. Industrial applications of programmable logic controllers and scada. Anchor Academic Publishing, 2016.

Suggested Readings

1. Ghosal, Ashitava. Robotics: fundamental concepts and analysis. Oxford university press, 2006.
2. Lin, Patrick, Keith Abney, and George A. Bekey, eds. Robot ethics: the ethical and social implications of robotics. MIT press, 2014.

3. Yamamoto, Ikuo. Practical robotics and mechatronics: marine, space and medical applications. Institution of Engineering and Technology, 2016.
4. Shell, Richard. Handbook of industrial automation. CRC press, 2000.
5. Lamb, Frank. Industrial automation: hands-on. McGraw-Hill Education, 2013.
6. Jack, Hugh. Automating manufacturing systems with PLCs. Lulu. com, 2009.

St Thomas College Palai Autonomous

Programme	**BSc (Hons) Physics**					
Course Name	**Op amp and Linear Integrated Circuits**					
Type of Course	**DSE**					
Course Code	**24U5PHYDSE307**					
Course Level	**300**					
Course Summary	A course on operational amplifiers (op-amps) typically covers the fundamental principles, characteristics, and applications of these essential electronic components. Throughout the course, students may engage in practical experiments, circuit design projects, and simulations to reinforce theoretical concepts and gain hands-on experience with operational amplifiers					
Semester	5	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	1	0	75
Pre-requisites, if any	Basics of semiconductor physics					

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	To understand the key characteristics parameters and applications of operational amplifiers	K, U	1
2	To make use of OP-AMP to design circuits such as Amplifiers, differentiator and Integrator ,filters and comparators	U, A	1,2,3
3	To Compare and contrast different types of operational amplifier configurations	U	1,2
4	Analyse the performance of operational amplifier circuits based on design goals and specifications	U, A, An	1,2,3
5	Compare and contrast different types of operational amplifier configurations	A,An,E,C,S	1,2,3

6	Analyse the performance of operational amplifier circuits based on design goals and specifications	E	1,2
7	To design various circuits by applying the theoretical foundations of op amps for different applications	A,An,S,C	1,2,3
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Introduction to operational amplifiers**		**13**	
	1.1	Introduction	2	1
	1.2	Basic information of op-amp	2	1,2
	1.2	ideal operational amplifier	2	1,3
	1.3	inverting and non-inverting amplifier	2	1,2,3
	1.4	voltage buffer	3	1,2,3
	1.5	summing amplifier	2	1,2,3
		Reference: [Text Book-1 chapter-2]		
2	**Applications of Operational Amplifiers**		**17**	
	2.1	Instrumentation amplifier	1	1,2,3,4
	2.2	Integrator and differentiator	3	1,2,3,4
	2.3	V to I converter and I to V converter	3	1,2,3,4
	2.4	log and antilog amplifier	2	1,2,3,4
	2.5	comparator- Regenerative comparator (Schmitt trigger)	3	1,2,3,4
	2.6	waveform generators- square wave (astable multivibrator), monostable multivibrator, triangular wave generator	3	1,2,3,4
	2.7	voltage regulator- series op amp regulator-IC voltage regulation	2	1,2,3,4
		Reference: [Text Book-1 chapter-4,5,6]		

3	**Operational amplifiers Feedback Configurations**		**15**	
	3.1	op-amp with negative feedback-block diagram representation of feedback configuration	5	1,3
	3.2	voltage series feedback: Negative Feedback, closed loop voltage gain, input resistance with feedback, output resistance with feedback	5	1,3
	3.3	voltage shunt feedback: closed-loop voltage gain, inverting input terminal at virtual ground, input resistance with feedback, output resistance with feedback	5	1,3
		Reference: [Text Book 2 chapter 4]		
4	**Practicals**		**30**	
	1	Op-amp -Square wave generator		5,6,7
	2	Op-amp -First order Low Pass Filter (design, Construction and Study)		5,6,7
	3	Op-amp -High Pass Filter (design, Construction and Study)		5,6,7
	4	Op-amp -Pulse Width Modulation		5,6,7
	5	Op-amp -A/D Convertor		5,6,7
	6	Op-amp -Summing Amplifier		5,6,7
	7	Op-amp -inverter, non-inverter, buffer for AC input Voltages		5,6,7
	8	Op-amp -Differential Amplifier		5,6,7
	9	Op-amp - Integrator		5,6,7
	10	Op-amp -Differentiator		5,6,7
	11	Op-amp -Converter -Current -Voltage		5,6,7
	12	Op-amp -Voltage Follower		5,6,7
5	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Tutorials, Seminars/ Presentations Activities, Practical sessions
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 marks** **Formative assessment** ● Quiz ● Assignment ● Seminar **Summative assessment** ● Written test **Practical:15 marks** ● Lab involvement ● Viva
	B. End Semester Examination (ESE) **Theory: 50 marks, duration 1.5 hrs** ● Short answer type questions: Answer any 7 questions out of 10(7*2=14) ● Short essay-type questions: Answer any 4 questions out of 6(4*6=24) ● Essay type questions: Answer any 1 question out of 2(1*12=12) **Practical: 35 marks, duration 2 hrs** ● Lab Exam:30 marks ● Record: 5 marks

Text Book

1. Linear Integrated Circuits D. Roy Choudhury,Shail.B.Jain-4th Edn. New Age International Publishers.
2. Op-amps and linear integrated circuits R.A. Gayakwad 4th Edn.PHI

References

1. Electronic Devices (Electron Flow Version), 9/E Thomas L. Floyd, Pearson
2. Fundamentals of Electronic Devices and Circuits 5 th Ed. David A. Bell, Cambridge.
3. A Textbook of Applied Electronics, R.S. Sedha – S. Chand (2005)

St Thomas College Palai Autonomous

Programme	**BSc (Hons) Physics**					
Course Name	**Solar Cell Technology: From Fundamentals to Applications**					
Type of Course	**SEC**					
Course Code	**24U5PHYSEC300**					
Course Level	**300**					
Course Summary & Justification	This course is designed to meet the growing demand for skilled professionals in the renewable energy sector, specifically in the field of solar photovoltaics.					
Semester	5	Credits		3		Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	0	0	45
Pre-requisites	Knowledge in Basic Solid state Physics					

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	To understand the Solar Radiation, its implications and critically evaluate the advantages and disadvantages	U, An	1,2
2	To interpret the concept of direct and indirect band gaps and their implications for the behaviour of charge carriers in semiconductors	U, An	1,2
3	To analyze the generation of photovoltage and light-generated current in P-N junctions under illumination, and evaluate key characteristics of solar cells	An, S	1,2,3
4	To design and simulate solar cell systems for different applications	A,S,An,C	1,2,3
5	To apply theoretical concepts to analyze and evaluate different types of solar cell technologies, including crystalline silicon, thin film, and	A, An, S	1,2,3

	emerging technologies.		
6	To evaluate the design, structure, and performance of solar photovoltaic modules and assess factors influencing solar PV system efficiency and reliability	A,An,S, E	1,2,3

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Unit	Course description	Hrs	CO No.
1	**Introduction To Solar Energy And Semiconductors**		**12**	
	1.1	World energy requirement-Current status of renewable energy sources- place of photovoltaics- Advantages and Disadvantages of solar energy- world production of solar PV modules and cost	2	1
	1.2	The sun as the source of Radiation-Solar constant-spectral distribution of extra- Basic Earth Sun angles-diffuse radiation-availability of solar radiation- power from solar energy	2	1
	1.3	Arrangements of atoms in space –formation of energy bands –energy band model- Metal, insulator and semiconductor- direct and indirect band gap- charge carriers in semiconductors	4	2
	1.4	Bonding in semiconductors- -intrinsic and extrinsic semiconductors -carrier concentration and distribution –Carrier motion in semiconductors- drift and diffusion motion- generation of carriers - recombination of carriers	4	2
2	**Fundamentals Of Solar Cells**		**16**	
	2.1	P-N junction introduction-equilibrium condition- space charge region- P N junction potential- PN Junction in non-equilibrium condition- generation of photo voltage- light generated current- I-V equation	4	3
	2.2	Solar cell characteristics- losses in solar cell- model of a solar cell-effect of various parameters	3	3
	2.3	Solar cell design- design for high I_{sc}- design for high V_{oc} - design for high FF- solar simulator J-V measurement- Quantum Efficiency measurement	5	3,4

	2.4	Growth of Solar PV industry and Si requirement- Production of Si wafers- Processes used in Solar cell technologies – High-efficiency Si solar cells- Areas of improvement and efficiency gain (all qualitative)	4	3,4
3	**Emerging Solar Cell Technologies**		**17**	
	3.1	Thin film solar cell technologies – materials for thin film technologies-thin film deposition techniques (qualitative)- amorphous Si solar cell technology- cadmium telluride solar cell technology – CIGS solar cell technology-thin film crystalline Si solar cell technology	5	5, 6
	3.2	Emerging solar cell technologies-organic and dye-sensitized solar cells- GaAs solar cells – Thermo photovoltaics- beyond single junction efficiency limit- approaches to overcome single junction efficiency limit	5	5,6
	3.3	Solar photovoltaic modules- series and parallel connection- design and structure of PV module- PV Module power output- introduction to batteries-factors affecting battery performance- Batteries for PV systems	7	5,6
4	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Leverage a blended learning approach with a mix of lectures and interactive discussions. Most importantly industry visits and onsite visits
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 marks** **Formative assessment** ● Quiz ● Assignments ● Seminar

	- Viva **Summative assessment** - Skill assessment test
	B. End Semester Examination (ESE) **Total: 50 marks, duration 1.5 hrs** 1. Evaluate theoretical and conceptual knowledge: 20 marks 2. Skill assessment test: 30 marks

Textbooks

1. Solar Photovoltaics: Fundamental, Technologies and Applications; C.S. Solanki; 2011; Prentice Hall of India.
2. Solar Energy: Fundamentals and Applications; H. P. Garg& J. Prakash; 2000; Tata McGraw-Hill.

References

1. Chenming, H. and White, R.M., Solar Cells from B to Advanced Systems, McGraw Hill Book Co, 1983
2. Chetan Singh Solanki, Solar Photovoltaics : Fundamentals Technologies And Applications,PHI Learning, 2015
3. D.P. Kothari, RENEWABLE ENERGY SOURCES AND EMERGING TECHNOLOGIES, PHI Learning; 3rd edition, 2022
4. Jay Warmke, Designing and Installing Solar PV Systems: Commercial and Large Residential Systems,Blue Rock Station LLC, 2022

St Thomas College Palai Autonomous

Programme	**BSc (Hons) Physics**
Course Name	**Physics Using Computational Tools**
Type of Course	**SEC**
Course Code	**24U5PHYSEC301**
Course Level	**300**
Course Summary	This course provides a comprehensive introduction to computational methods in physics, encouraging students to become proficient in using computers as tools to solve real-world physics problems. The emphasis on algorithm development allows students to build a strong foundation for future research or applications in computational physics.

Semester	5	Credits			3	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	**0**	**0**	**0**	**45**
Pre-requisites, if any	Basic knowledge of Calculus					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	To gain a foundational understanding of computational methods in physics.	U	1, 2, 3
2	To Develop the ability to create and implement algorithms for solving physics problems	A, S, C	1, 2, 3
3	To Gain experience in applying numerical methods to a range of physical scenarios.	A	1, 2, 3
4	To develop computational solutions for complex physics problems independently.	C	1, 2, 3

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Unit	Course description	Hrs	CO No.
1	**Algebraic and Transcendental Equations**		**14**	
	1.1	Bisection Method - Newton Raphson method (two equation solution) - Regula-Falsi Method	5	1
	1.2	Solution of a system of linear algebraic equations - Gauss elimination method with pivoting -Gauss-Jordan method for matrix inversion- Gauss-Seidel iterative method	5	1
	1.3	Power method and Jacobi's method to solve eigenvalue problems.	4	1
2	**Curve fitting: Regression and interpolation**		**14**	
	2.1	Least squares Regression- fitting a straight line, parabola, polynomial and exponential curve	4	1,2
	2.2	Finite difference operators-forward differences, divided difference; shift, average and differential operators- Newton's forward difference interpolation formulae- Lagrange interpolation polynomial	6	1,2
	2.3	Newton's divided difference interpolation polynomial; Cubic spline method.	4	1,2
3	**Numerical Differentiation, Integration and Solution of ordinary differential equations**		**17**	
	3.1	Numerical Differentiation formulae - Maxima and minima of a tabulated function-	4	1,2
	3.2	Newton- Cote general quadrature formula - Trapezoidal, Simpson's 1/3, 3/8 rule	4	1,2
	3.2	Taylor Series Method, Picard's method	4	1,2
	3.4	Euler's and modified Euler's method –Heun's method- Runge Kutta methods for 1st and 2nd order	5	1,2
4	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, Presentations, Discussions
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 marks** **Formative assessment** ● Quiz ● Assignments ● Seminar **Summative assessment** ● MCQ Exams
	B. End Semester Examination (ESE) **Theory: 50 marks, duration 1.5 hrs** ● Short answer type questions: Answer any 7 questions out of 10(7*2=14) ● Short essay-type questions: Answer any 4 questions out of 6(4*6=24) ● Essay type questions: Answer any 1 question out of 2(1*12=12)

Textbooks

1. Numerical Methods, Balagurusamy, TMH
2. Numerical Methods for Scientists and Engineers- K Sankara Rao- PHI
3. Sastry, S. S. Introductory Methods of Numerical Analysis. India, PHI Learning, 2012.

References

1. Pang, Tao. An Introduction to Computational Physics. Spain, Cambridge University Press, 2006.
2. Sauer Timothy Numerical Analysis, 3rd edition, Pearson, 2017.
3. Sankara Rao S. Numerical Methods For Scientists And Engineers PHI Learning Pvt. Ltd., 2017.
4. Verma, R. C. Computational Physics: An Introduction. India, New Age International, 2007.

SEMESTER 6

St Thomas College Palai Autonomous

<table>
<tr><td>Programme</td><td colspan="6">BSc (Hons) Physics</td></tr>
<tr><td>Course Name</td><td colspan="6">Introduction to Solid State Physics</td></tr>
<tr><td>Type of Course</td><td colspan="6">DSC A</td></tr>
<tr><td>Course Code</td><td colspan="6">24U6PHYDSC300</td></tr>
<tr><td>Course Level</td><td colspan="6">300</td></tr>
<tr><td>Course Summary</td><td colspan="6">The course aims to deliver basic concepts in Solid State Physics and enable students to understand the properties of metals, insulators and semiconductors. After the completion of this course, students should be able to apply the different models to analyse the behaviours of materials and their relevance in scientific research and technological advancements.</td></tr>
<tr><td>Semester</td><td>6</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>3</td><td>0</td><td>1</td><td>0</td><td>75</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">Basic Concepts of Physics and Mathematics</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Explain crystal structure, Bravais Lattices, different crystal systems and Miller indices	U	1
2	Describe the principle of X-ray diffraction using Bragg’s law	U	1
3	Illustrate free electron theory and band theory and its role in governing the material properties	U, An	1, 2

4	Investigate the behaviour of solids using the Free Electron theory and band theory	U, A, An	1, 2
5	Distinguish metals, semiconductors and insulators based on E-k Diagram	U, A, An	1, 2
6	Discuss the basic physical properties of semiconductors	U	1
7	Explain the different electrical properties of solids	U	1
8	Investigate magnetic properties in solids and understand the role of magnetism in various materials.	A, An	1, 2
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	**Units**	**Course description**	**Hrs**	**CO No.**
1	**Crystal Structure**		**13**	
	1.1	The crystalline state. Basic definition of lattice, basis, and unit cell. The fourteen Bravais lattices and the seven crystal systems.	3	1
	1.2	Elements of symmetry, Nomenclature of crystal directions and crystal planes, Miller indices	3	1
	1.3	Examples of simple crystal structures, Amorphous solids and liquids, interatomic forces and Types of bonding.	3	1
	1.4	Basic ideas on Reciprocal lattice	2	2
	1.5	The diffraction condition and Bragg's law, Expression using reciprocal lattice, Applications of XRD.	2	2
2	**Free electron theory, Band Theory and Semiconductors**		**19**	
	2.1	Conduction electrons, The free-electron gas, Fermi distribution function, Fermi energy	3	3, 4
	2.2	Electrical conductivity, Collision Time, Electrical resistivity versus temperature	3	3
	2.3	Motion in a magnetic field: cyclotron resonance and Hall effect, Estimation of Hall Coefficients	3	3

	2.4	Failure of the free-electron model, Energy bands in solids, Bloch theorem- Bloch function, energy band diagram (E-k diagram), Distinction between Metals, insulators, and semiconductors. Direct and Indirect Band Gap.	5	5
	2.5	Semiconductors, Band structure, Carrier concentration, intrinsic and extrinsic semiconductors, mobility, drift velocity and conductivity	5	6
3	**Electrical and Magnetic Properties of Materials**		**13**	
	3.1	The dielectric constant and polarizability, local field, Clausius-Mossotti relation, Sources of polarizability, Piezoelectricity, Ferroelectricity, Curie -Weiss law.	5	5,7
	3.2	Magnetic susceptibility, Classification of Magnetic Materials, Diamagnetism, Paramagnetism.	4	6
	3.3	Ferromagnetism in metals, Ferromagnetic domain, Magnetization process, Hysteresis, Antiferromagnetism and Ferrimagnetism	4	6
4	**Practical**		**30**	
	4.1	Study the Hall effect and estimate the following parameters (a)Carrier Concentration (b)Mobility (c)Hall Coefficient.		4,5
	4.2	Determination of e/k of Silicon.		5
	4.3	Measurement of resistivity of a semiconductor by four-probe method at different temperature and determination of band gap.		7
	4.4	Determination of band gap of a semiconductor by four-probe method.		7
	4.5	Study the temperature dependence of dielectric constant of a ceramic capacitor and verify Curie-Wiess law.		5, 7
	4.6	Study the variation of photoconductivity of a semiconductor with light intensity/wavelength.		6
	4.7	Draw the hysteresis curve (B – H Curve) of a ferromagnetic material and determine retentivity and coercivity.		8
	4.8	Electrical conductivity of metals and estimation of fermi energy.		7

5	**Teacher Specific Content**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, Presentations, Discussions
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory:25 marks** **Formative assessment** ● Quiz ● Assignment ● Seminar **Summative assessment** ● Written test **Practical:15 marks** ● Lab involvement ● Viva
	B. End Semester Examination (ESE) **Theory: 50 marks, duration 1.5 hrs** ● Short answer type questions: Answer any 7 questions out of 10(7*2=14) ● Short essay-type questions: Answer any 4 questions out of 6(4*6=24) ● Essay type questions: Answer any 1 question out of 2(1*12=12) **Practical:35 marks, duration 2 hrs** ● Lab Exam:30 marks ● Record: 5 marks

Textbook

1. Ali Omar, M. Elementary Solid State Physics Principles and Applications, Pearson India, 1st Edition 2001

References

1. Pillai, S.O., Solid state Physics, New Age International Private Limited 10yh Edition 2022.
2. Kittel, C., Introduction to Solid State Physics, Wiley India Pvt. Ltd. 8th Edition, 2004.
3. Ashcroft, N. W. and Mermin, N. D. Solid State Physics, Cengage Learning 1st Edition, 2003.
4. Puri, R. K., Babbar, V. K. Solid State Physics, S. Chand Publishing 2010.

St Thomas College Palai Autonomous

Programme	**BSc (Hons) Physics**					
Course Name	**Thermal and Statistical Physics**					
Type of Course	**DSC A**					
Course Code	**24U6PHYDSC301**					
Course Level	**300**					
Course Summary	This course provides a comprehensive exploration of thermodynamics, covering fundamental concepts such as the laws of thermodynamics, entropy, and their applications. Students will delve into the principles governing energy transfer and transformation, gaining a deep understanding of the relationships and equations that govern thermodynamic systems. Additionally, the course introduces basic concepts of statistical mechanics, offering a well-rounded perspective on the principles that govern physical systems at the macroscopic and microscopic levels.					
Semester	6	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	**0**	**1**	**0**	**75**
Pre-requisites, if any	Nil					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	To Explain the concept of energy in thermal equilibrium and the second law in thermodynamics	U	1,2
2	To Apply the concepts and laws of thermodynamics in solving problems in thermodynamic systems such as gases, heat engines and refrigerators	U, A	1,2

3	To critically analyse the concepts of entropy, free energy and chemical potential and apply in real physical systems and processes	U, A, An	1,2
4	To make use of use statistical physics methods, such as Boltzmann distribution, Gibbs distribution, Fermi-Dirac and Bose-Einstein distributions to solve simple problems in physical systems.	A, An,E	1,2
5	To apply the concepts of thermal and statistical physics in experiments and simulations	U, An, A	1,2
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	**Units**	**Course description**	**Hrs**	**CO No.**
1	**Energy in thermal Physics and Second law**		**15**	
	1.1	Thermal equilibrium, Ideal gas, Heat and Work, Compression Work- Compression of ideal gas.	3	1
	1.2	Heat Capacities, Latent heat and Enthalpy	3	1
	1.3	Two state systems, Two state Paramagnet, Einstein Model of a Solid, Interacting systems, Very large numbers, Sterling's approximation.	5	1
	1.4	Multiplicity of monoatomic ideal gas, Interacting ideal gases, Entropy, Reversible and Irreversible process	4	1
2	**Thermodynamics**		**15**	
	2.1: **Interactions**			
	2.1.1	Temperature: Entropy and Heat- Predicting Heat Capacities, Measuring Entropies, Macroscopic View of Entropy.	3	2
	2.1.2	Mechanical Equilibrium and Pressure, Thermodynamic identity, Entropy and heat revisited. Diffusive equilibrium and Chemical Potential.	3	2
	2.2: **Engines and Refrigerators**			

	2.2.1	Heat Engines- Carnot Cycle, Refrigerators	3	2
	2.3: **Free energy and Chemical Potential**			
	2.3.1	Free Energy as Available Work. Thermodynamic identities.	3	3
	2.3.2	Free Energy as a Force toward Equilibrium. Extensive and intensive quantities. Gibbs free energy and chemical potential.	3	3
3	**Basic concepts of Statistical mechanics**		**15**	
	3.1	Boltzmann Distribution- Boltzmann Factor, Partition Function, Average Values	4	4
	3.2	Maxwell Speed Distribution.	3	4
	3.3	Quantum Statistics- Gibbs factor, Bosons and Fermions – Distribution function	5	4
	3.4	Degenerate Fermi Gases at Zero temperature (calculation of degeneracy pressure)	3	4
4	**Practicals**		**30**	5
	1	Thermistor – Resistance - Temperature characteristics and temperature coefficient of resistance.		
	2	Newton's law of cooling – Specific heat capacity of a liquid		
	3	Thermal conductivity of bad conductor – Lee's disc		
	4	Carey Foster's bridge – Temperature coefficient of resistance.		
	5	Electrochemical equivalent of Copper.		
	6 7	Hall Effect in Semiconductor. Determine the Hall coefficient, carrier concentration and carrier mobility Measurement of resistivity of a semiconductor by four-probe method at different temperature and determination of band gap.		
	8	Using any Probability Based Method, estimate the value of pi.		
	9	Simulate one dimensional Ising Model.		

5	**Teacher Specific Content**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Problem Solving. Laboratory experiments and simulations.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory:25 marks** **Formative assessment** ● Quiz ● Assignment ● Seminar **Summative assessment** ● Written test **Practical:15 marks** ● Lab involvement ● Viva
	B. End Semester Examination (ESE) **Theory: 50 marks, duration 1.5 hrs** ● Short answer type questions: Answer any 7 questions out of 10(7*2=14) ● Short essay-type questions: Answer any 4 questions out of 6(4*6=24) ● Essay type questions: Answer any 1 question out of 2(1*12=12) **Practical: 35 marks, duration 2 hrs** ● Lab Exam:30 marks ● Record: 5 marks

Text Book:

1. Daniel V. Schroder, An Introduction to Thermal Physics, First edition (2014), Pearson

References

1. Kerson Huang, Statistical Mechanics, John Wiley and Sons (2003).
2. F. Rief, Fundamentals of Statistical and Thermal Physics, McGraw Hill (1986).
3. D. Chandler, Introduction to Statistical Mechanics, Oxford University Press (1987)
4. L.D Landau and E.M Lifshitz, Statistical Physics (Vol-1),3rd Edition. Pergamon Press (1989)
5. Yung-Kuo Lim, Problems and Solutions in Thermodynamics and Statistical Mechanics, World Scientific (1990).

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<table>
<tr><td>Programme</td><td colspan="6">BSc (Hons) Physics</td></tr>
<tr><td>Course Name</td><td colspan="6">Sensors and Actuators</td></tr>
<tr><td>Type of Course</td><td colspan="6">DSE</td></tr>
<tr><td>Course Code</td><td colspan="6">24U6PHYDSE300</td></tr>
<tr><td>Course Level</td><td colspan="6">300</td></tr>
<tr><td>Course Summary</td><td colspan="6">This course provides a comprehensive understanding of sensors and actuators and various types of sensors and emerging technologies in sensing, such as smart sensors, fiber optic sensors, biosensors, and MEMS. The course also gives an introduction to actuators and different types of actuators.</td></tr>
<tr><td>Semester</td><td>6</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>4</td><td>0</td><td>0</td><td>0</td><td>60</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">Nil</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	To acquire in depth knowledge on different sensors and actuators and explain the physical principles underlying sensing and understand their applications.	U, A	1, 2
2	To analyze the differences in the principles of operation of various types of sensors and their applications	U, An	1, 2

3	To appreciate the emerging technologies in sensing such as smart sensors, fibre optic sensors, biosensors, thin film sensors, nanosensors, digital transducers, and encoders, and understand their applications	U, Ap	1, 2
4	To evaluate various types of actuators and their principles of operation and applications.	E	1,2
5	To understand the fundamentals of Microelectromechanical Systems (MEMS) technology and their applications in MEMS-based sensors and microactuators	U	1, 2
6	To analyze various types of microactuators, including electrostatic, magnetic, fluidic, shape memory alloys and those based on the piezoelectric effect, and evaluate their suitability for different applications.	U, An	1, 2
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Fundamentals of Sensors and Transducers**		**12**	
	1.1	Introduction to Sensors and Transducers, Definition, Classification, Parameters of sensors and transducers	2	1
	1.2	Physical Principles of Sensing: Capacitance, Magnetism, Induction, Resistance, Thermal expansion, thermal conduction	2	1
	1.3	Advanced sensing principles: Piezoelectric Effect, Pyroelectric Effect, Hall Effect, Seebeck and Peltier Effects	3	1
	1.4	Position, Displacement, and Level Sensors: Gravitational Sensors, Capacitive Sensors, Inductive and Magnetic Sensors, LVDT and RVDT, Eddy Current Sensors, Hall Effect Sensors, Magnetoresistive Sensors (Qualitative only)	5	1,2

2	**Advanced Sensor Technologies**		**18**	
	2.1	Angular/rotary movement transducers, Potentiometric Sensors, Synchros	3	1,2
	2.2	Motion detectors: Visible and Near-Infrared Light Motion Detectors, Far-Infrared Motion, PIR motion Detectors, Optical Sensors, Ultrasonic Sensors, Radar Sensors	5	1,2
	2.3	Temperature Sensors: Thermoresistive Sensors, Thermocouple, Semiconductor P-N Junction Sensors, Optical Temperature Sensors, Acoustic Temperature Sensor, Piezoelectric Temperature Sensors (Qualitative only)	5	1,2
	2.4	Emerging Technologies: Smart sensors, Definition and characteristics, Fiber optic sensors, Biosensors, Thin Film sensors, Nanosensors, Digital transducers, Encoders and their applications (Qualitative only)	5	1,3
3	**Introduction to Actuators**		**15**	
	3.1	Introduction to Actuators	2	1,4
	3.2	Types of Actuators: Servo Motor, Stepper Motor, Relay, Solenoid, Linear actuator (Qualitative only)	3	1,4
	3.3	Pneumatic actuator- Electro-Pneumatic actuator; cylinder, rotary actuators, Mechanical actuating system: Hydraulic actuator (Qualitative only)	5	1,4
	3.4	Electrical actuating systems: Solid-state switches, Solenoids, Electric Motors- Principle of operation and its application: D.C motors - AC motors, Synchronous Motors; Stepper motors - Piezoelectric Actuator. (Qualitative only)	5	1,4
4	**Microelectromechanical Systems (MEMS)**		**15**	
	4.1	MEMS (Microelectromechanical Systems): Fundamentals of MEMS technology.	4	1,5
	4.2	MEMS-based sensors for various applications, principles and examples, Force and pressure micro sensors, acceleration micro sensors, chemical sensors and flow micro sensors. (Qualitative only)	5	1,5
	4.3	Micro Actuators: Actuation principle, shape memory effects-one way, two way and pseudo elasticity. (Qualitative only)	3	1,6

	4.4	Types of micro actuators- Electrostatic, Magnetic, Fluidic, Inverse piezo effect (Qualitative only)	3	1,6
5	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Demonstrations, Presentations, Discussions
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory:30 marks** **Formative assessment** ● Quiz ● Assignments ● Seminar **Summative assessment** ● Written tests
	B. End Semester Examination (ESE) **Total: 70 marks, duration 2 hrs** ● Short answer type questions: Answer any 10 questions out of 12(10*3=30) ● Short essay type questions: Answer any 4 questions out of 6(4*7=28) ● Essay type questions: Answer any 1 question out of 2(1*12=12)

Textbook

1. Patranabis D, Sensor and Actuators, Prentice Hall of India (Pvt) Ltd., 2005.
2. Actuators: Basics and Applications, H. Janocha (Ed.)

References

1. Renganathan S, Transducer Engineering, Allied Publishers (P) Ltd., 2003.
2. Sensors and Transducers. Third Edition. Ian R. Sinclair.Newnes Publisher, ISBN 0 7506 4932 1
3. Sergej Fatikow and Ulrich Rembold, “Microsystem Technology and Microbotics”, First edition, Springer –Verlag Newyork, Inc, 1997.
4. Jacob Fraden, “Hand Book of Modern Sensors: Physics, Designs and Application” Fourth edition, Springer, 2010.

St Thomas College Palai Autonomous

Programme	**BSc (Hons) Physics**					
Course Name	**Applied Computational Techniques in Chaos Theory**					
Type of Course	**DSE**					
Course Code	**24U6PHYDSE301**					
Course Level	**300**					
Course Summary	This course delves into nonlinear dynamics, teaching students to model systems, understand complex behaviors, and apply computational techniques for analyzing real and synthetic data.					
Semester	6	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	**0**	**0**	**0**	**60**
Pre-requisites, if any	Basics of Mechanics and Calculus.					

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	To understand the basics of nonlinear dynamics and bifurcation theory with specific examples from various fields.	U	1,2
2	To apply differential or difference equations to model system dynamics, incorporating real-world case studies.	A, An, S	1,2
3	To analyze periodic, aperiodic, and complex behaviors in nonlinear dynamical systems through practical examples.	U	1,2
4	To assess the dynamical stability of nonlinear systems using both theoretical concepts and practical simulations.	U	1,2
5	To utilize specific computational methods and software tools to simulate complex systems, demonstrating their practical applications.	U, A, S	1,2

6	To develop skills in managing and analyzing real or synthetic data, with applications in various interdisciplinary fields.	U, S	1,2
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Fundamentals of Nonlinear Dynamics and Bifurcation Theory**		**15**	
	1.1	A brief history of Nonlinear dynamics, Importance of Nonlinear dynamics, World as a dynamical system.	3	1
	1.2	One dimensional flows, fixed points, Linear stability analysis	5	1
	1.3	Bifurcations, saddle-node bifurcation, Transcritical bifurcation, Pitchfork bifurcation**.**	7	1
2	**Exploring Dynamical Systems**		**13**	
	2.1	Phase portraits, numerical computation of phase portraits, Fixed points, Lorenz equations, Roessler system	5	2,3
	2.2	Chaos on a strange attractor, Defining Attractor and Strange attractor	4	2,3
	2.3	Lorenz map-ruling out stable limit cycles, Exploring parameter space.	4	2,3
3	**Complexity and Chaos in Dynamical Systems**		**17**	
	3.1	One dimensional maps, Fixed points and linear stability, Logistic map: numerics, Logistic map: analysis, Lyapunov exponent.	6	3
	3.2	Fractals, countable and uncountable sets, Cantor set, Sierpinski Carpet Dimension of self-similar fractals.	6	3
	3.3	Box dimension, Pointwise correlation dimensions, Reconstruction of Phase space (qualitative only)	5	3
4	**Tutorial**		**15**	4,5,6

	4.1	Simulate the Logistic Map and demonstrate the period-doubling route to chaos.	3	
	4.2	Compute the Lyapunov exponent of the logistic map and identify the onset of chaos.	2	
	4.3	Obtain the Box Counting dimension of the logistic map by varying the bifurcation parameter	2	
	4.4	Explore the parameter space of the Rössler system using a bifurcation diagram and demonstrate the period-doubling route to chaos	2	
	4.5	Simulate the Lorenz system using the Runge-Kutta method and explore the parameter space.	2	
	4.6	Reconstruct the phase space of a chaotic system from time series data using delay embedding and obtain the phase plot	2	
	4.7	Obtain the Lyapunov spectra of the Lorenz attractor	2	
5	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Tutorials, Seminars/ Presentations Practical sessions
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 marks** **Formative assessment** ● Quiz ● Assignment ● Seminar **Summative assessment** ● Written test

	B. End Semester Examination (ESE) **Theory: 70 marks, duration 2 hrs** ● Short answer type questions: Answer any 10 questions out of 12(10*3=30) ● Short essay type questions: Answer any 4 questions out of 6(4*7=28) ● Essay type questions: Answer any 1 question out of 2(1*12=12)

Textbook

1. Strogatz, Steven H. Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and Engineering. Westview Press, 2014.
2. Analysis of Observed Chaotic Data, Abarbanel, Henry D.I., Springer, 1995.

References

1. Deterministic Chaos, N. Kumar, Universities Press.
2. Chaos and Nonlinear Dynamics, RC. Hilborn, Oxford University Press.
3. Chaotic Dynamics: An Introduction, G.L. Baker, and J.P. Gollub, CUP, 1993.
4. Chaos in Dynamical System, E. Ott, Cambridge University Press.
5. S. Neil Rasband, Chaotic Dynamics of Nonlinear Systems, Courier Dover Publications

St Thomas College Palai Autonomous

Programme	**BSc (Hons) Physics**					
Course Name	**Introduction to Plasma Physics**					
Type of Course	**DSE**					
Course Code	**24U6PHYDSE302**					
Course Level	**300**					
Course Summary	This course in plasma physics provides a comprehensive exploration of fundamental concepts and phenomena. Students will learn the nature and definition of plasmas, understanding their occurrence in natural settings. The curriculum covers the critical Debye shielding concept, illustrating the impact of temperature on plasma behavior. By understanding plasma waves, students can analyze and evaluate the validity of the plasma approximation, gaining insights into electromagnetic and electrostatic oscillations. The course provides an in-depth study of space plasma phenomena, considering their influence on Earth's magnetic field, space weather, and the practical applications of observational methods. Students will also gain insights into theory and working of state of art measurement techniques like Ionosndae and Langmiur Probe.					
Semester	6	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	**0**	**0**	**0**	**60**
Pre-requisites, if any	Students should have a strong foundation in classical physics, particularly in mechanics and electromagnetism. Proficiency in mathematical concepts such as calculus, linear algebra, and differential equations are essential for understanding the complex equations and analyses involved. Basic knowledge of quantum mechanics can be beneficial. While not mandatory, a background in astronomy and astrophysics would enhance comprehension of space plasma phenomena.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	To identify the plasma parameters, conditions and plasma phenomena	K, U	1,2,3
2	To solve problems related to Debye shielding in various plasma environments by applying the fundamental knowledge of plasma	U, A	1,2,3
3	To Analyze the behaviour of plasma in Electromagnetic field to understand the Plasma dynamics	U, A, An	1,2,3
4	Evaluate the validity of the plasma approximation in different scenarios	A, An, E	1,2,3
5	To analyse the waves in plasma for determining the plasma dynamics , plasma manipulation and diagnostics for different applications	A, An, E	1,2,3
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Introduction to Plasma**		**20**	
	1.1	Definition of Plasma; Plasma as the fourth state of matter; Plasma production; Some basic plasma phenomenon	4	1
	1.2	Macroscopic neutrality; Debye Shielding; Plasma frequency.	4	1
	1.3	Occurrence of plasma in nature; Solar wind; Magnetosphere and Van Allen radiation belts	4	1
	1.4	Ionosphere; Plasma beyond the solar system	3	1
	1.5	Theoretical description of plasma phenomena	5	2

2	**Plasmas as Fluids**		**15**	
	2.1	Uniform E and B Field; Non Uniform B Field; Non Uniform E Field.	5	3
	2.2	Time-Varying E Field; Time-Varying B Field; Relation of Plasma Physics to Ordinary Electromagnetics	5	3,4
	2.3	The Fluid Equation of Motion; Fluid Drifts Perpendicular to B; Fluid Drifts Parallel to B; The Plasma Approximation.	5	3,4
3	**Waves in Plasmas**		**15**	
	3.1	Representation of Waves; Group Velocity; Plasma Oscillations.	3	3,4
	3.2	Electron Plasma Waves; Sound Waves; Ion Waves; Validity of the Plasma Approximation; Comparison of Ion and Electron Waves; Electrostatic Electron Oscillations Perpendicular to B; Electrostatic Ion Waves Perpendicular to B.	4	3,4
	3.3	The Lower Hybrid Frequency; Electromagnetic Waves with Bo = 0; Experimental Applications; Electromagnetic Waves Perpendicular to Bo; Cutoffs and Resonances.	5	3,4
	3.4	Electromagnetic Waves Parallel to Bo; Experimental Consequences; Hydromagnetic Waves; Magnetosonic Waves; The CMA diagram.	3	3,4
4	**Application of Plasma Physics**		**10**	
	4.1	Controlled thermonuclear fusion & Magnetohydrodynamic generator	4	5
	4.2	Plasma propulsion	3	5

	4.3	Other plasma devices	3	5
5	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Discussion sessions, Online resources for simulations Problem solving session
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 marks** **Formative assessment** ● Quiz ● Assignments ● Seminar **Summative assessment** ● Written tests
	B. End Semester Examination (ESE) **Total: 70 marks, duration 2 hrs** ● Short answer type questions: Answer any 10 questions out of 12(10*3=30) ● Short essay type questions: Answer any 4 questions out of 6(4*7=28) ● Essay type questions: Answer any 1 question out of 2(1*12=12)

Textbook

1. Bittencourt, J. A., Fundamentals of Plasma Physics, 3ed, Springer, New York, 2004.
2. Chen, Francis F. *Introduction to plasma physics*. Springer Science & Business Media, 2012.
3. Kelley, Michael C. *The Earth's ionosphere: Plasma physics and electrodynamics*. Academic Press, 2009.

Reference

1. Hargreaves, J. K. "The Solar-Terrestrial Environment, Atmospheric and Space Science Series." (1992).
2. Kivelson, Margaret Galland, and Christopher T. Russell, eds. *Introduction to space physics*. Cambridge University Press, 1995.
3. Rishbeth, Henry, and Owen K. Garriott. "Introduction to ionospheric physics." *Introduction to ionospheric physics* (1969).
4. Khomich, Vladislav Yu, Anatoly I. Semenov, and Nicolay N. Shefov. *Airglow as an indicator of upper atmospheric structure and dynamics*. Springer Science & Business Media, 2008.
5. Bhatnagar, Arvind, and William Charles Livingston. *Fundamentals of solar astronomy*. Vol. 6. World Scientific, 2005.
6. Arnab Rai Chowdhury, Nature's Third Cycle, Oxford University Press.
7. Schrijver, Carolus J., and Cornelis Zwaan. *Solar and stellar magnetic activity*. Vol. 34. Cambridge University Press, 2008.

St Thomas College Palai Autonomous

Programme	**BSc (Hons) Physics**					
Course Name	**Nanophotonics**					
Type of Course	**DSE**					
Course Code	**24U6PHYDSE303**					
Course Level	**300**					
Course Summary	This course will provide an overview of Nanophotonics To expose students to the principle of Nanophotonics- the emerging area of Nanotechnology and Photonics that deals with light-matter interactions on the nanometer scale (1-100 nm). This course will also give an overview of the phenomena involved in such devices, types of devices in the present context of the technology andthe photonic crystal based nano-photonic systems and surface plasmon based applications					
Semester	6	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	**0**	**0**	**0**	**60**
Pre-requisites, if any	Nil					

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No.**
1	To analyse the photon propagation through media of different dielectric constants and electron propagation under various interaction potentials.	U, A	1.2,3
2	To explain the quantum confinement effects in optical properties of material	U	1.2,3
3	To examine plasmonic effects in metal nanoparticles	U, A	1.2,3
4	To understand the different applications of Nanophotonics	U	1.2,3
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom Transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Foundations of nanophotonics**		**15**	
	1.1	Photons and electrons: similarities and differences, Free-Space Propagation, Confinement of Photons and Electrons, Propagation Through a Classically Forbidden Zone: Tunneling, Localization Under a Periodic Potential: Bandgap, Cooperative Effects for Photons and Electrons	7	1
	1.2	Nanoscale optical interactions- axial and lateral nanoscopic localizations	4	1
	1.3	Nanoscale confinement of electronic interactions; Quantum Confinement Effects, Nanoscopic Interaction Dynamics, New Cooperative Transitions, Nanoscale Electronic Energy Transfer Cooperative Emission	4	1
2	**Quantum confined materials**		**15**	
	2.1	Quantum wells, Quantum wires, Quantum dots, Quantum rings	5	2
	2.2	Manifestations of quantum confinement- Optical properties, nonlinear optical properties;	3	2
	2.3	Quantum confined stark effect, Dielectric confinement effect.	3	2
	2.4	Superlattices; Core-Shell Quantum Dots and Quantum Dot-Quantum Wells, Quantum confined structures as lasing media	4	2
3	**Plasmonics**		**15**	
	3.1	Metallic nanoparticles, nanorods and nanoshells;	3	3
	3.2	local field enhancement; subwavelength aperture plasmonics; plasmonic wave guiding;	3	3
	3.3	applications of metallic nanostructures; radiative decay engineering	3	3

	3.4	Nanostructure and excited states; up converting nanophores; photon avalanche; quantum cutting.	6	3
4	**Applications**		**15**	
	4.1	Photonic Crystal fibers: Basics concepts, features and theoretical modelling of photonic crystals, photonic crystal fibers	7	4
	4.2	Nanocomposites: Nanocomposites as photonic media, Nanocomposites for optoelectronics two photon lithography, plasmon printing,	4	4
	4.3	Nanoparticles for optical diagnostics and targeted therapy, Up-Converting Nanopores For Bioimaging, Biosensors, self -cleaning glasses	4	4
5	**Teacher Specific Content**.			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, Presentations, Discussions
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 marks** **Formative assessment** ● Quiz ● Assignments ● Seminar **Summative assessment** ● Written tests
	B. End Semester Examination (ESE) **Total: 70 marks, duration 2 hrs**

	● Short answer type questions: Answer any 10 questions out of 12(10*3=30) ● Short essay type questions: Answer any 4 questions out of 6(4*7=28) ● Essay type questions: Answer any 1 question out of 2(1*12=12)

Textbook

1. Prasad, Paras N.. Nanophotonics. Wiley India, 2016

References

1. Gaponenko, Sergey V. Introduction to Nanophotonics. N.p., Cambridge University Press, 2010.

St Thomas College Palai Autonomous

Programme	**BSc (Hons) Physics**					
Course Name	**Nanostructured Materials and Its Applications**					
Type of Course	**DSE**					
Course Code	**24U6PHYDSE304**					
Course Level	**300**					
Course Summary	This course aims to establish a solid comprehension of essential concepts pertaining to nanomaterials, covering their structural characteristics, variation in density of states and optical, electronic and magnetic properties influenced by size. Moreover, students will acquire an in-depth knowledge of various types of nanomaterials, techniques for synthesis, and methods for characterization. The course ensures that students develop insights into the wide-ranging applications of nanoparticles across fields such as electronics, optics, biomedicine, energy, and sensing technologies.					
Semester	6	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practicum	Others	
		4	0	0	0	60
Pre-requisites, if any	Basics of Solid State Physics					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the significance of length scales in the context of nanomaterials.	U	1,2
2	Analyse the key features that distinguish nanosystems from macroscopic systems	An	1.2
3	Understand the behavior of density of states of 2D, 1D and 0D	U, Ap	1,2

	nanomaterials		
4	Compare and contrast the structures and properties of different kinds of nanomaterials, nanoclusters and nanocomposites	E	1,2
5	Understand different synthesis methods and characterization of nanomaterials	U	1,2
6	Understand the use of different techniques such as X-ray diffractometer (XRD), Scanning Probe Microscope (SPM), Scanning Tunneling Microscope (STM), and Atomic Force Microscope (AFM) to characterize nanomaterials	U	1,2
7	Appreciate real-world applications of nanomaterials in electronics, optics, biomedicine, energy, and sensing technologies.	Ap	1,2
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom Transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**1.1: Introduction to Nanomaterials**		**8**	
	1.1.1	Length scales in physics, Features of nanosystems	1	1,2,3
	1.1.2	The density of states of materials at the nanoscale, Variation of band gap with the size of the nanocrystal.	3	3
	1.1.3	Properties of Nanomaterials - Mechanical properties of nanomaterials, Optical properties of nanomaterials, Electrical and Magnetic properties of nanomaterials (qualitative ideas only)	4	4
	1.2: Quantum Mechanics for Nanoscience		**9**	
	1.2.1	Size-effects in Smaller Systems, Quantum Behaviour of Nanometric World	3	2
	1.2.2	Applications of Schrödinger Equation - Infinite potential well	3	2
	1.2.3	Quantum confinement effect of carriers in 3D, 2D, 1D nanostructures and its consequences.	3	2

2	**2.1:- Types of Nanomaterials**		**8**	
	2.1.1	Semiconductor nanomaterials, Metal Nanocrystals, Surface plasmon resonance	3	4
	2.1.2	Carbon nanomaterials - Fullerenes, Carbon nanotubes and Graphene, (basic idea)	3	4
	2.1.3	Nanoclusters - Metal nanoclusters, Magic number	2	4
	2.2:- Synthesis Techniques of Nanomaterials		**10**	
	2.2.1	Top down and Bottom up approach, Lithographic process	2	5
	2.2.2	Plasma arc discharge, sputtering. Evaporation: Thermal evaporation, Electron beam evaporation.	3	5
	2.2.3	Chemical Vapour Deposition (CVD). Pulsed Laser Deposition, Molecular Beam Epitaxy	3	5
	2.2.4	Sol-Gel Technique, Electrodeposition.	2	5
3	**Characterization of Nanomaterials**		**13**	
	3.1	Atomic Structures -Grain size determination – XRD (Debye Scherrer equation)	5	6
	3.2	Microscopy – Scanning Electron Microscope (SEM), Tunneling Electron Microscope (TEM)	5	6
	3.3	Scanning Tunneling Microscope (STM), Atomic Force Microscope (AFM).	3	6
4	**Applications of Nanotechnology**		**12**	
	4.1	Nano-electronics: Quantum dots, nanowires and thin films for photonic devices (LED, solar cells). Single electron devices (no derivation).	2	7
	4.2	CNT based transistors, Micro Electromechanical Systems (MEMS), Nano Electromechanical Systems (NEMS)	2	7
	4.3	Nano-optics, Biological/bio-medical applications- drug delivery.	2	7
	4.4	Photovoltaic, fuel cells, batteries and energy-related applications, High strength nanocomposites, Nanoenergetic materials, Nanoscale chemical and bio-sensing	4	7

	4.5	Thin film chemical sensors, gas sensors, biosensors	2	7
5	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecturing, Problem Solving, Simulations, Demonstration/ Powerpoint Presentations
Assessment Types	**MODE OF ASSESSMENT** **A.Continuous Comprehensive Assessment (CCA)** **Theory: 30 marks** **Formative assessment** ● Quiz ● Assignments ● Seminar **Summative assessment** ● Written tests
	B. End Semester Examination (ESE) **Total: 70 marks, duration 2 hrs** ● Short answer type questions: Answer any 10 questions out of 12(10*3=30) ● Short essay type questions: Answer any 4 questions out of 6(4*7=28) ● Essay type questions: Answer any 1 question out of 2(1*12=12)

Textbook

1. Chattopadhyay, Kalyan K. *Introduction To Nanoscience And Nanotechnology*. PHI Learning Pvt. Ltd., 2009.
2. Poole, Charles P., and Frank J. Owens. "Introduction to nanotechnology." (2003): 145-150.

3. Pradeep, T. *Nano: the essentials: understanding nanoscience and nanotechnology*. McGraw-Hill Education, 2007.

References

1. Callister Jr, William D. *Materials science and engineering an introduction*. 2007.
2. Vollath, Dieter. "Nanomaterials an introduction to synthesis, properties and application." *Environmental Engineering and Management Journal* 7.6 (2008): 865-870.
3. M. Hosokawa, K. Nogi, M. Naita, T. Yokoyama, *Nanoparticle Technology Handbook (Elsevier, 2007).*
4. Bharat Bhushan, *Springer Handbook of Nanotechnology (Springer-Verlag, Berlin, 2004)*
5. Gabor . L et al, *Introduction to Nanoscience and Nanotechnology,*
6. Hornyak, G. Louis, Tibbals, H. F., Dutta, Joydeep, *Fundamentals of Nanotechnology*, CRC Press, 2009
7. V. S. Muraleedharan and A Subramaniam, *Nano Science and Technology,* Ane Books Pvt. Ltd, New Delhi
8. John D, Miller, *A Handbook on Nanophysics,* Dominant Publishers and Distributors, Delhi-51
9. Charles P Poole Jr. and Frank J Owens, *Introduction to Nanotechnology*, Wiley Students Edition
10. K Ohno et. al, *Nano-and micro materials,* Springer International Edition 2009, New Delhi
11. Brundle, Evans and Wilson, Butterworth – Heinmann, E*ncyclopedia of Materials Characterization, Surfaces, Interfaces, Thin Films, Eds., 1992*
12. Bharat Bhushan (Ed.), *Springer Handbook of nanotechnology,* Springer-Verlag, Berlin, 2004
13. M. Hosokawa, K. Nogi, M. Naita, T. Yokoyama (Eds.), *Nanoparticle Technology Handbook* –, Elsevier

St Thomas College Palai Autonomous

Programme	**BSc (Hons) Physics**					
Course Name	**Classical Theory of Fields**					
Type of Course	**DSE**					
Course Code	**24U6PHYDSE305**					
Course Level	**300**					
Course Summary	Fields and their classical dynamics is introduced from the basics. It enables the learner to grasp the quantization of fields with a relative ease. Non-perturbative configurations that are important in many physical systems are also introduced.					
Semester	6	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	**0**	**0**	**0**	**60**
Pre-requisites, if any	Nil					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Formulate the classical dynamics of fields	U An E	1, 2
2	Understand important field systems	An E	1, 2
3	Imbibe the significance of symmetry and the phenomena of symmetry breaking	U An	1, 2
4	Familiarize non-perturbative aspects of field theories	An E C	1, 2

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Fields as continuous systems, Real scalars**		**15**	
	1.1	Transition from discrete to continuous system	4	1
	1.2	Lagrangian for continuous system	3	1
	1.3	The real scalar field: variational principle	4	1
	1.4	Noether's theorem, Hamiltonian	4	1, 3
2	**Complex scalar and Gauge fields**		**15**	
	2.1	Complex scalar fields	4	2
	2.2	Electromagnetic field and their interactions	4	2
	2.3	The Yang-Mills field	5	2
	2.4	Proca field	2	2
3	**Spontaneous breaking of symmetry and Higgs phenomenon**		**15**	
	3.1	Secret symmetries in classical field theory	1	3
	3.2	The idea of spontaneous symmetry breakdown	2	3
	3.3	Goldstone bosons in an Abelian model	3	3
	3.4	Goldstone bosons in the general case	3	3
	3.5	The Higgs phenomenon in the Abelian model	3	3
	3.6	Yang-Mills fields and the Higgs phenomenon in the general case, Summary	3	3
4	**Topological configurations**		**15**	
	4.1	Sine-Gordon kink	3	4
	4.2	Vortex lines	4	4

	4.3	Dirac monopole	4	4
	4.4	Instantons (excluding quantum tunneling)	4	4
5	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Tutorials Seminars/ Presentations, Activities
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 marks** Formative assessment ● Quiz ● Assignments ● Seminar Summative assessment ● Written tests
	B. End Semester Examination (ESE) **Total: 70 marks, duration 2 hrs** ● Short answer type questions: Answer any 10 questions out of 12(10*3=30) ● Short essay type questions: Answer any 4 questions out of 6(4*7=28) ● Essay type questions: Answer any 1 question out of 2(1*12=12)

Textbook

1. Classical Mechanics, H Goldstein, C Poole, J Safko (Unit 1.1 - 1.2)
2. Quantum Field Theory, L. H. Ryder

References

1. Classical field theory, H Nastase
2. Introduction to Quantum field theory, M Peskin and D Schroeder
3. Aspects of Symmetry, S. Coleman
4. Solitons and instantons, R Rajaraman

St Thomas College Palai Autonomous

Programme	**BSc (Hons) Physics**					
Course Name	**Advanced Power System Design**					
Type of Course	**DSE**					
Course Code	**24U6PHYDSE310**					
Course Level	**300**					
Course Summary and Justification	The syllabus explores emerging applications in power electronics. Introduces power devices such as power BJT, MOSFET and IGBT including practical applications. Hands-on training includes circuit designing of motor drivers, voltage regulators and inverters.					
Semester	6	**Credits**			4	**Total Hours**
Course Details	**Learning Approach**	**Lecture**	**Tutorial**	**Practical**	**Others**	
		4	0	0	0	60
Pre-requisites	Knowledge in basic electronics					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PSO No
1	Understand the working of different components of advanced power systems	U	1, 2
2	Design different power control circuits	An	1, 2
3	Apply hands on expertise in making power circuits	A	1, 2, 10
4	Construct Inverter and motor driver circuits	C	1, 2, 10

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Unit	Course description	Hrs	CO No.
1	**Introduction to Power electronics components**			
	1.1	Safety precautions and guidelines for handling high voltage AC and DC supplies.	3	1
	1.2	Structure and working of Power BJT	4	1
	1.3	Characteristics of Power BJT. Testing of power BJT.	3	1
	1.4	Power transistors 2N3055- Analyse the Datasheet, Circuit diagram and working of voltage regulator.	5	1, 2
2	**Application of MOSFET**			
	2.1	Structure of MOSFET, Working of Depletion type and Enhancement type	3	1
	2.2	Characteristics of Mosfet, Mosfet testing using multimeter, Working of Mosfet as a switch	3	1, 2
	2.3	Basic structure and working of BLDC motor (Basic ideas only), BLDC motor driver and speed control using MOSFET	5	2, 3
	2.4	DC Motor control using H bridge, DC motor driver circuit using Mosfet.	4	2, 3
3	**Application of IGBT**			
	3.1	Structure of IGBT, Characteristics, Testing of IGBT	3	1
	3.2	Working of IGBT as a switch. Simple switching circuit to control the current through a bulb.	4	2
	3.3	Adjustable power supply design using IGBT, Circuit diagram and working.	4	3, 4
	3.4	DC to AC conversion using IGBT- Square wave inverter circuit, Pulse width modulated Sine wave inverter (Qualitative ideas only).	4	4
4	**Hands on Session**			
	4.1	1. Build an adjustable voltage regulator using 2N3055 transistor 2. Simple dc motor driver using a single MOSFET and potentiometer 3. Build a 12V bulb flasher using MOSFET	15	3, 4

		4. Construct an inverter circuit (12V DC to 230V AC) using two or more Mosfets.		
5		**Teachers Specific content**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Leverage a blended learning approach with a mix of lectures, interactive discussions, and hands-on lab sessions
Assessment Types	**MODE OF ASSESSMENT** A. **Continuous Comprehensive Assessment (CCA)** **Theory: - 30 Marks** 1. Internal Test – One MCQ based and one extended answer type 2. Seminar Presentation – a real time application of emerging technology to be identified and present it as seminar 3. Hands on training or software simulation **B. Semester End examination** Written Test (70 marks)**, duration 2 hrs** 1. MCQ - 20 Marks 2. Short answer questions (6 out of 8 questions)-6x5=30 marks 3. Essay questions -2 out of 4 - 2x10=20 marks

Textbook

1. Vithayathil, Joseph. "Power electronics: principles and applications." (No Title) (1995).
2. Rashid, Muhammad H. "Devices, circuits, and applications." Power Electronics
3. Handbook; Academic: New York, NY, USA (2007): 245-259.

References

1. Baliga, B. Jayant. "Trends in power semiconductor devices." IEEE Transactions on electron Devices 43.10 (1996): 1717-1731.
2. Sedha, R. S. A textbook of applied electronics. S. Chand Publishing, 2008.
3. Patel, Rahul Kumar, et al. "Introduction to various controlling techniques for inverters
4. as a part of undergraduate course in power electronics." 2014 IEEE International
5. Conference on MOOC, Innovation and Technology in Education (MITE). IEEE, 2014.

6. Power Electronics, B. R. Gupta and V. Singhal- S.K. Kataria & Sons
7. Bimbhra P. S., and Surinder Kaur. Power electronics. Vol. 2. Delhi, India: Khanna publishers, 2012.

Programme	**BSc (Hons) Physics**					
Course Name	**Introduction to Nuclear Physics**					
Type of Course	**DSE**					
Course Code	**24U6PHYDSE307**					
Course Level	**300**					
Course Summary	This course will build foundations of nuclear physics including nuclear properties, reactions, decay processes and experimental techniques. It will also include basics of particle physics, recent advances in HEP experiments and few biomedical applications.					
Semester	6	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	**0**	**0**	**0**	**60**
Pre-requisites, if any	Basic knowledge of Algebra, Quantum Physics and Relativity					

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	To gain knowledge about basic properties of nuclei and details of popular nuclear models for studying nuclear structure behaviour	U	1,2
2	To make use of the laws of nuclear decay for better understanding of related nuclear reaction dynamics	A	1,2
3	To familiarize with the fundamental forces and the basic properties and classification of elementary particles	U	1
4	To discuss about the different radiation detectors	U	1
5	To solve elementary problems in nuclear and particle physics, and analysing the experimental results.	An, A	1,2

6	To discuss about the recent advances in High Energy Physics and few biomedical applications	U	1,3
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	**Units**	**Course description**	**Hrs**	**CO No.**
1	**Nuclear Properties and Models**		**15**	
	1.1	**Nuclear Properties** Nuclear composition, Nuclear properties (Nuclear radii, mass, charge, density, Spin, magnetic moment and Quadrupole moment) Atomic mass unit (u)conversion– Stability curve - Binding energy- Binding energy curve	7	1
	1.2	**Nuclear Models** Liquid drop model - Semi empirical binding energy formula with correction factors - Shell model - Nuclear forces- Meson theory of nuclear forces – Discovery of pion.	8	1
2	**Nuclear Transformation and Reactions**		**15**	
	2.1	**Nuclear Transformation** Radioactive decay, units of radioactivity, Half life, Mean life, Radiometric dating, geological dating, the four Radioactive series, Alpha decay – disintegration energy (tunnel theory excluded), Beta decay, positron emission, electron capture, neutrino hypothesis – Gamma decay	7	2
	2.2	**Nuclear Reactions** The concept of cross section – geometric and interaction cross section, reaction rate – Nuclear reactions, Resonance, Center of mass coordinate system, Q value of nuclear reaction – Nuclear fission – Nuclear reactors – Breeder reactors - Nuclear fusion in stars – Formation of heavier elements – Fusion reactors – Confinement methods, Radiation hazards	8	2
3	**Introduction to Particle Physics**		**15**	

	3.1	**Interactions and particle classification** Interactions and particles, Leptons, Neutrinos and Antineutrinos, other leptons, Hadrons, Resonance particles –	5	3
	3.2	Elementary particle quantum numbers, Quarks, Basic concepts of Quarks – color, flavor, Field Bosons, Standard Model, Quark confinement	4	3
	3.3	**Experimental Particle Physics** Different types of radiation detectors - gas ionization, scintillation and semiconductor detectors.	3	4,5
	3.4	Van de Graaff accelerator, LINAC, cyclotron, Synchrotron (basic ideas only), particle physics experiments and data analysis, Modern Synchrotrons. (Relativistic Heavy Ion Collider (RHIC) and Large Hadron Collider (LHC), Quark Gluon Plasma, Higgs Boson. (The Large Hadron Collider – Home page, The Relativistic Heavy Ion Collider – Home page) (Basic Ideas on all topics given)	3	
4	**Biomedical Applications and Recent Advances**		**15**	
	4.1	Biological effects of radiation; radiation therapy for cancer treatment, Medical imaging using X-rays, ultrasound, MRI (Magnetic Resonance Imaging), CT (Computed Tomography), PET. Radioiodine therapy	5	6
	4.2	**Recent Advances** Neutrino and dark matter search at SNOLAB, Neutrino oscillations – Indian Neutrino Observatory (INO), Matter-antimatter asymmetry, LIGO- Gravitational Wave detection, James Webb telescope, Fusion research and prospects, Tokamak – Princeton Plasma Physics Lab, ISRO missions.	10	6
5	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, Tutorial (module 4), Field visit,
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 marks** **Formative assessment** ● Quiz ● Assignments

	● Seminar **Summative assessment** ● Written tests
	B. End Semester Examination (ESE) **Total: 70 marks, duration 2 hrs** ● Short answer type questions: Answer any 10 questions out of 12(10*3=30) ● Short essay type questions: Answer any 4 questions out of 6(4*7=28) ● Essay type questions: Answer any 1 question out of 2(1*12=12)

Text Books:

1. Arthur Beiser, Shobith Mahajan, S Rai Choudhari. Concepts of Modern physics. 6th edition. Tata Mc Graw Hill education Private Limited.
2. R. Murugeshan, Modern Physics, S . Chand & Company Ltd.

SUGGESTED READINGS

1. Hughes, Ian Simpson. *Elementary particles*. Vol. 10. Cambridge University Press, 1991.
2. Krane, Kenneth S. *Introductory nuclear physics*. John Wiley & Sons, 1991.
3. Fernow, Richard Clinton. *Introduction to experimental particle physics*. Cambridge university press, 1986.

St Thomas College Palai Autonomous

Programme	**BSc (Hons) Physics**					
Course Name	**Introduction to Cross Platform Mobile Application Development using Flutter**					
Type of Course	**SEC**					
Course Code	**24U6PHYSEC300**					
Course Level	**300**					
Course Summary & Justification	This course provides a comprehensive introduction to Mobile app development using Flutter, encouraging students to become proficient in programming to solve real world problems.					
Semester	6	Credits			3	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		2	**0**	**1**	**0**	**60**
Pre-requisites	Basic knowledge in Software programming					

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Comprehensive understanding of mobile platforms, app types, Flutter architecture, Dart programming language, and essential tools and setups required for Flutter development.	U	1,2
2	Apply best practices for UI design, layout, and navigation to create intuitive and user-friendly mobile applications.	U, A	1,2,3

3	Understand the importance of state management in Flutter applications and get a basic knowledge in the most common state management solutions	U, A	1,2,3
4	Ability to fetch and parse the data from remote sources persistence of data	U, A	2
5	Hands on sessions: Ability to design and develop mobile apps using Flutter	A, S, C	3,9
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs.	CO No.
1	**1.1: Introduction to Mobile Application Development and Dart Programming Fundamentals**		**9**	
	1.1.1	Overview of mobile platforms (Android, iOS), Types of Mobile Apps(Native, CrossPlatform, Hybrid, Web apps) and its advantages and disadvantages, Understanding Flutter Architecture: Widgets, Rendering Engine, and Framework.	1	1
	1.1.2	Installation and Setup: Guide on installing Flutter SDK and setting up development environments (Android Studio/VS Code/Xcode).	1	1
	1.1.3	Introduction to Dart: Basics of Dart programming language including variables, data types, operators, and control flow.	2	1
	1.1.4	Functions and Classes: Working with functions, defining classes, constructors, and object-oriented concepts in Dart.	4	1

	1.1.5	Dart Packages and Dependencies: Managing dependencies using pub package manager, exploring commonly used Dart packages.	1	1
	1.2: Flutter Widgets and Layouts		**7**	
	1. 2.1	Introduction to Widgets: Understanding Stateless Widget and Stateful Widget, widget tree.	1	2
	1.2.2	Layouts in Flutter: Exploring various layout widgets like Row, Column, Stack, and Expanded for building UIs.	2	2
	1.2.3	Gestures and Interactivity: Handling user input with GestureDetector, InkWell, and handling touch events.	2	2
	1.2.4	Navigation and routing in Flutter apps	2	2
2	**2.1. State Management in Flutter**		**4**	
	2.1.1	Understanding state and managing state using setState() method	2	3
	2.1.2	Introduction to state management solutions: Provider, Bloc	2	3
	2.2. Working with Data and APIs		**6**	
	2.2.1	Fetching data from APIs using HTTP requests in Flutter, Parsing JSON data and handling asynchronous operations	2	4
	2.2.2	Storing and retrieving data locally using shared preferences and SQLite databases	2	4
	2.2.3	Integrating Firebase for backend services (authentication, Firestore database, push notification)	2	4
	2.3. Advanced Topics and App Deployment		**4**	
	2.3.1	Testing and Debugging: Writing unit tests, widget tests, and integration tests, debugging common issues. Mobile Application Security	2	4

	2.3.2	Deployment and App Store Submission: Building your Flutter app for Android and iOS, preparing for deployment, and submitting to Google Play Store and Apple App Store.	2	4
3	**Hands-on session**		**30**	
	3.1.	Your First Flutter App: Building a "Hello World" app, understanding the project structure, and running it on an emulator or device.	7	1
	3.2.	Hands-on exercises: Build an app with basic widgets and navigation.	8	2
	3.3.	Hands-on exercises: implementing state management in Flutter apps	7	3
	3.4.	Practical exercises: building data-driven Flutter applications	8	1,2,3,4
5	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Discussions, Hands on sessions
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory:15 marks** **Formative assessment** ● Assignment ● Seminar ● Tutorial work ● Case Study/Project/ Site Visit/Workshop/Internship **Summative assessment**

	● MCQ exams **Practical:15 marks** ● Lab involvement ● Viva
	B. End Semester Examination **Theory: 35 marks, duration 1.5 hrs** ● Short essay type questions: Answer any 7 questions out of 10 (7x 5 = 35) **Practical: 35 marks, duration 2 hrs** ● Lab Exam:30 marks ● Record: 5 marks

Textbook

1. Michael Katz, Kevin David Moore, Vincent Ngo & Vincenzo Guzzi Flutter Apprentice Second edition
2. Zammetti, Frank. *Practical Flutter*. Berkeley, CA: Apress, 2019.

References

1. Chopra, Deepti, and Roopal Khurana. *Flutter and Dart: Up and Running: Build native apps for both iOS and Android using a single codebase (English Edition)*. BPB Publications, 2023.

St Thomas College Palai Autonomous

Programme	**BSc (Hons) Physics**					
Course Name	**Essential machine learning for physicists**					
Type of Course	**SEC**					
Course Code	**24U6PHYSEC301**					
Course Level	**300**					
Course Summary	The objective of this course is to equip Physics undergraduate students with practical skills in machine learning using scikit-learn, enabling them to apply data-driven approaches to analyze and interpret complex physical phenomena.					
Semester	6	Credits			3	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		2	**0**	**1**	**0**	**60**
Pre-requisites, if any	Basic skills in Python programming					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Describe various methods and techniques for machine learning and its application in Physics	U, A	1,2,3
2	Explain different learning techniques in machine learning	U	1,2,3
3	Make use of clustering for the analysis of data	U, A	1,2,3
4	Evaluate the performance of various classification and Regression methods	A, An, E	1,2,3

****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Introduction to Machine Learning and Data Preprocessing**		**20**	
	1.1 : Introduction to Machine			
	1.1.1	Introduction, Machine learning versus traditional programming.	1	1
	1.1.2	How machine learning works, Applications of machine learning	1	1
	1.1.3	Classifications of Machine Learning: Supervised Learning, Unsupervised Learning, Semi supervised Learning, Reinforcement Learning	1	1
	1.1.4	**Data in Machine Learning** **Splitting of Data:** Splitting of Data, Validation Data, Testing Data Data Processing, Data cleaning, Feature Scaling	4	1, 2
	1.1.5	**Practical** Implementing using scikit-learn module in python	3	1, 2
	1.2: Feature Selection techniques			
	1.2.1	**Wrapper Method:** Forward selection, Backward elimination	1	2
		Practical Implementing using scikit-learn module in python	2	
	1.2.2	**Filter Method:** Chi-square method, Pearson's Correlation, Variance Threshold, ANOVA (Analysis Of Variance)	2	2
		Practical Implementing using scikit-learn module in python	2	

	1.2.3	**Embedded Methods:** Regularization, Random Forest Importance	1	2
		Practical Implementing using scikit-learn module in python	2	
2	**Classification Algorithms**		**20**	
	2.1	**Artificial Neural Network:** Input Layer, Hidden Layer, Output Layer **Backpropagation algorithm:-** Standard Backpropagation (Gradient Descent), Adaptive Learning Rate Methods	2	3, 4
		Practical Implementing using scikit-learn module in python	3	
	2.2	**Support vector machines (SVM):-** Hyperplane, Linear SVM, Nonlinear SVM	2	3, 4
		Practical Implementing using scikit-learn module in python	3	
	2.3	Random forest algorithm, K Nearest Neighbor (KNN) algorithm, Naive Bayes classifier	2	3, 4
		Practical Implementing using scikit-learn module in python	3	
	2.4	**Hyperparameters, Hyperparameter Tuning:-** GridSearchCV, RandomizedSearchCV	2	3, 4
		Practical Implementing using scikit-learn module in python	3	
3	**Regression Algorithms**		**20**	
	3.1	Linear Regression, Logistic Regression	4	3, 4
		Practical Implementing using scikit-learn module in python	3	
	3.2	Polynomial Regression, Support Vector Regression**I**	4	3, 4
		Practical Implementing using scikit-learn module in python	3	
	3.3	Decision Tree Regression, Random Forest Regression	3	3, 4

		Practical Implementing using scikit-learn module in python	3	
4	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures with hands on training, discussions
	MODE OF ASSESSMENT
Assessment Types	**A. Continuous Comprehensive Assessment (CCA) - 30 marks**
	Formative assessment ● Assignment ● Seminar ● Tutorial work ● Lab involvement
	Summative assessment ● **Seminar**: Each student presents a detailed mathematical formulation of a chosen classification or regression algorithm and a feature selection technique. ● Viva
	B. End Semester Examination (ESE)
	Evaluate theoretical and conceptual knowledge: 35 marks ● **Seminar**: Each student presents a detailed mathematical formulation of a chosen classification or regression algorithm and a feature selection technique. This presentation will take place in the classroom in front of all faculty members and an external expert. ● Viva
	Skill assessment test: 35 marks ● Lab Exam: 25 marks**, duration 1 hrs** Develop a machine learning program utilising scikit-learn module in Python using any one of the methods discussed. Viva: 10 marks

Textbook

1. Jose, Jeeva. Introduction to Machine Learning, Khanna Book Publishing 2020.

References

1. Saleh, Hyatt. Machine Learning Fundamentals: Use Python and scikit-learn to get up and running with the hottest developments in machine learning. Packt Publishing, 2018.
2. Hackeling, Gavin. Mastering Machine Learning with Scikit-Learn (Python) Year: 2017.
3. Burkov, Andriy. The hundred-page machine learning book, Ingram short title 2019.
4. https://scikit-learn.org/stable/

St Thomas College Palai Autonomous

<table>
<tr><td>Programme</td><td colspan="6">BSc (Hons) Physics</td></tr>
<tr><td>Course Name</td><td colspan="6">Physics for Resilience: Strategies in Disaster Management</td></tr>
<tr><td>Type of Course</td><td colspan="6">VAC</td></tr>
<tr><td>Course Code</td><td colspan="6">24U6PHYVAC300</td></tr>
<tr><td>Course Level</td><td colspan="6">300</td></tr>
<tr><td>Course Summary</td><td colspan="6">This syllabus is designed to provide students with a comprehensive understanding of disaster management from a physics perspective, preparing them to contribute effectively to disaster prevention, mitigation, and response efforts.</td></tr>
<tr><td>Semester</td><td>6</td><td colspan="3">Credits</td><td>3</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>0</td><td>45</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">Nil</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	To discuss the different types of disasters and their implications.	U	1,3,6,7,10
2	To predict natural disasters by applying the principles of physics	An, E	1,3,6,7,10
3	To assess the effectiveness of disaster preparedness and mitigation strategies.	A, An, E	1,3,6,7,8,9, 10
4	To demonstrate knowledge of physics-based technologies used in disaster management.	U, A	1,2,3,6,10
5	To support the ethical and socially responsible approaches in disaster recovery.	A, An, E	1,2,3,6,7,8, 9,10

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Introduction to Disaster Management**		**15**	
	1.1	Overview of Disasters and Their Types	3	1
	1.2	Role of Physics in Disaster Management	3	1
	1.3	Disaster Preparedness and Mitigation	3	1
	1.4	Emergency Response Systems	3	1
	1.5	Case Studies and Real-life Applications	3	1
2	**Physics-based Models for Disaster Prediction**		**15**	
	2.1	Mathematical Models for Natural Disasters	3	2
	2.2	Seismology and Earthquake Prediction	3	2
	2.3	Meteorological Phenomena and Weather-related Disasters	3	2
	2.4	Tsunami and Storm Surge Predictions	3	2
	2.5	Technological Tools in Disaster Prediction	3	2
3	**Physics in Disaster Recovery and Reconstruction**		**15**	
	3.1	Physics-based Technologies in Search and Rescue Operations	3	2,3,4
	3.2	Rehabilitation and Reconstruction Strategies	3	2,3,4
	3.3	Environmental Impact Assessment after Disasters	3	2,3,4

	3.4	Considerations in Disaster Recovery	2	2,3,4
	3.5	Case Studies on Post-Disaster Recovery: Ethical and Social	2	5
	3.6	Disaster management in daily life, Lightning protection methods for buildings, Fire and gas leakage protection methods.	2	5
4	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Field Work, Documentaries & Films, Debates, Activities
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 marks** **Formative assessment** ● Quiz ● Assignments ● Seminar **Summative assessment** ● MCQ Exams
	B. End Semester Examination (ESE) **Total: 50 marks, duration 2 hrs** Multiple Choice Questions (25*2=50)

Textbook

1. Muller, Richard A. Physics and technology for future presidents: an introduction to the essential physics every world leader needs to know. Princeton University Press, 2010.

References

1. Earthquake Physics and Fault-System Science by Thomas H. Jordan
2. Hughes, Peter, and Nigel J. Mason. Introduction to environmental physics: planet earth, life and climate. CRC Press, 2001.
3. Erickson, Paul A. Emergency response planning: for corporate and municipal managers. Elsevier, 1999.

St Thomas College Palai Autonomous

Programme	**BSc (Hons) Physics**					
Course Name	**Environmental Physics and Human Rights**					
Type of Course	**VAC**					
Course Code	**24U6PHYVAC301**					
Course Level	**300**					
Course Summary	Environmental physics aims at an interdisciplinary study of physical principles applied to understanding and addressing environmental challenges, encompassing topics such as climate change, air and water quality, and the dynamics of ecosystems. Understanding and safeguarding fundamental human rights is an essential aspect of global citizenship, encompassing awareness of their infringement and strategies for protection.					
Semester	**6**	Credits			3	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	**0**	**0**	**0**	**45**
Pre-requisites, if any	**Nil**					

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	To understand the basics of the ecosystem, biodiversity, renewable and non-renewable resources.	U	3,6,7,8,10
2	To value the environmental policies and practices after analyzing the environmental pollution and its adverse effects.	U, A, An, E	1,2 3,6,7,8,10
3	To achieve Sustainable development goals by positively correlating the environment with human communities.	U, A, An	1, 2 3, 6, 7, 8,10
4	To examine the surrounding environment via fieldwork.	U, A	1, 2, 3, 6, 7, 8, 10

5	To reframe the concepts and methods to safeguard the environment.	U, A, An, E	1, 2, 3, 6, 7, 8, 10
6	To make the community aware of the rights they have.	U, A, E	1, 2, 3, 6, 7, 8, 10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Unit 1.1: Introduction to environmental studies**		**5**	
	1.1.1	Multidisciplinary nature of environmental studies	1	1, 4, 6
	1.1.2	Scope and importance; Concept of sustainability and sustainable development.	2	1, 4
	1.1.3	Structure and function of ecosystem; Energy flow in an ecosystem: food chains, food webs and ecological succession. Case studies of the following ecosystems : a) Forest ecosystem b) Grassland ecosystem c) Desert ecosystem d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)	2	1, 4
	Unit 1.2: Natural Resources: Renewable and Non-renewable Resources		**10**	
	1.2.1	Land resources and land use change; Land degradation, soil erosion and desertification. Deforestation: Causes and impacts due to mining, and dam building on the environment, forests, biodiversity and tribal populations	4	1, 4
	1.2.2	Water: Use and over-exploitation of surface and groundwater, floods, droughts, and conflicts over water (international & inter-state).	4	1,4
	1.2.3	Energy resources: Renewable and non-renewable energy sources, use of alternate energy sources, growing energy needs, case studies.	2	1, 4

2	**Environmental Pollution and Environmental Policies & Practices**		**20**	
	2.1	Environmental pollution: types, causes, effects and controls; Air, water, soil and noise Pollution, Nuclear hazards and human health risks	8	2, 3, 6
	2.2	Solid waste management: Control measures of urban and industrial waste, Pollution case studies	4	2,3,6
	2.3	Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture Environment Laws: Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and Control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act. International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD).	5	2, 3, 6
	2.4	Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context.	3	2, 3, 6
3	**Human Rights**		**10**	
	3.1	Introduction to Human Rights Classification of Human Rights	2	3, 4, 5, 6
	3.2	Basic international Human Rights Document UDHR, ICCPR, ICESCR, NHRC, SHRC	3	3, 4, 5, 6
	3.3	Human Rights in Indian Constitution Six categories of fundamental rights Human Rights of women, minorities, children	3	3,4
	3.4	Six Organs of united Nations	2	3,4
4	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture method, Case Study Method Assignment, Interactive Session, Group discussion
Assessment Types	**MODE OF ASSESSMENT**

	A. Continuous Comprehensive Assessment (CCA) **Theory: 25 marks** **Formative assessment** ● Quiz ● Assignments ● Seminar **Summative assessment** ● MCQ Exams
	B. End Semester Examination (ESE) **Total: 50 marks, duration 1.5 hrs** Multiple Choice Questions (25*2=50)

Textbook

1. Odum, Eugene Pleasants, and Gary W. Barrett. *Fundamentals of ecology*. Vol. 3. Philadelphia: Saunders, 1971.
2. Bharucha Erach, Text Book of Environmental Studies for undergraduate Courses. University Press, IInd Edition 2013 (TB)
3. Dr. H. O. Agarwal, Human Rights, Central Law Publications

References

1. Singh, J. S., S. P. Singh, and S. R. Gupta. *Ecology, environmental science & conservation*. S. Chand Publishing, 2014.
2. Martin, C. (2011). Environment and Human Rights. Edward Elgar Publishing.

SEMESTER 7

St Thomas College Palai Autonomous

<table>
<tr><td>Programme</td><td colspan="6">BSc (Hons) Physics</td></tr>
<tr><td>Course Name</td><td colspan="6">Statistical Physics</td></tr>
<tr><td>Type of Course</td><td colspan="6">DCC</td></tr>
<tr><td>Course Code</td><td colspan="6">24U7PHYDCC400</td></tr>
<tr><td>Course Level</td><td colspan="6">400</td></tr>
<tr><td>Course Summary</td><td colspan="6">Statistical mechanics is a branch of physics that deals with understanding collective response from the single particle behavior. This course explains how the statistical approach is effective in predicting the thermodynamics of a system from the constituent particles. The course discusses how probability theory can be used to derive relations between the microscopic and macroscopic properties of matter.</td></tr>
<tr><td>Semester</td><td>7</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>3</td><td>0</td><td>1</td><td>0</td><td>75</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">Nil</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	To understand the statistical basics of Thermodynamics	U	1,2
2	To Understand canonical ensemble and arrive at an expression for partition function and its computation	U	1,2
3	To apply ensemble theory to explain the behaviour of different systems	U,A	1,2
4	To Apply classical and quantum probability distribution functions to various systems.	A,An	1,2
5	To apply the concepts of statistical Physics to experiments and simulations	A,S	1,2

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Basics Formulation**		**20**	
	1.1	The Statistical Basis of Thermodynamics: Macroscopic and microscopic states. Connection between thermodynamics and statistics. The entropy of mixing and Gibbs paradox.	5	1
	1.2	Elements of Ensemble Theory: Phase space of a classical system. Liouville's theorem, Micro-canonical ensemble	5	2
	1.3	Canonical ensemble with examples, Energy fluctuations in the canonical ensemble. Equipartition theorem. The physical significance of statistical quantities in canonical ensemble.	6	2
	1.4	Classical systems.	4	2
2	**Basics Formulation**		**10**	
	2.1	Grand canonical Ensemble, Equilibrium between system and energy-particle reservoir, system in grand canonical ensemble, Physical significance of various statistical quantities	7	3
	2.2	Fluctuations in grand canonical ensemble.	3	3
3	**Ideal Bose and Fermi system**		**15**	
3	3.1	Ideal gas in quantum-micro canonical ensemble, Ideal gas in other quantum mechanical ensembles	5	4
	3.2	Statistics of the occupation numbers.	3	4
	3.3	Thermodynamic behaviour of ideal Bose gas,	4	4
	3.4	Thermodynamics of the ideal Fermi system.	3	4
4	**Practicals**		**30**	
	1	Study the temperature dependence of the dielectric constant of a ceramic capacitor and verify Curie-Wiess law		5

	2	Thermal conductivity using dynamic method		5
	3	Fermi energy of a semiconductor		5
	4	To determine e/k using silicon diode		5
	5	Using Monte Carlo Method, generate a set of particles with speeds distributed according to the Maxwell-Boltzman distribution using Rejection sampling.		5
	6	Plot the Maxwell speed distribution function for a 3-dimensional system at various temperatures. Calculate the average speed, root mean square speed, and most probable speed. Analyze how these speeds vary with temperature and compare the distribution curves.		5
	7	Plot the specific heat of solids as a function of temperature using: a) The Dulong-Petit law, b) The Einstein model, c) The Debye model. Additionally, compare the results from each model and analyze how well they match experimental data at low, intermediate, and high temperatures.		5
	8	Plot Planck's law of black body radiation as a function of wavelength and frequency at different temperatures. Compare these plots with the Rayleigh-Jeans law and Wien's distribution law at a given temperature. Additionally, calculate and analyze the peak wavelength/frequency for each temperature using Wien's displacement law and discuss the limitations of the Rayleigh-Jeans law at short wavelengths and the Wien's distribution law at long wavelengths.		5
5	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecturing, Problem Solving.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)**

	Theory: 25 marks **Formative assessment** ● Quiz ● Assignment ● Seminar **Summative assessment** ● Written test **Practical:15 marks** ● Lab involvement ● Viva
	B. End Semester Examination (ESE) **Theory: 50 marks, duration 1.5 hrs** ● Short answer type questions: Answer any 7 questions out of 10(7*2=14) ● Short essay-type questions: Answer any 4 questions out of 6(4*6=24) ● Essay type questions: Answer any 1 question out of 2(1*12=12) **Practical: 35 marks, duration 2 hrs** ● Lab Exam:30 marks ● Record: 5 marks

Textbook

1. R.K. Pathria, Statistical Mechanics, second edition (1996), Butterworth, Heinemann.

References

1. Introductory Statistical Mechanics, R. Bowley&M.Sanchez, 2nd Edn. 2007, Oxford University Press, Indian Edition.
2. Fundamentals of Statistical and Thermal Physics, F. Rief, McGraw Hill (1986).
3. Statistical Mechanics, Kerson Huang, John Wiley and Sons (2003).
4. Statistical Mechanics, Satyaprakash& Agarwal, KedarNath Ram Nath Pub. (2004).
5. Introductory Statistical Physics, S.R.A. Salinas, Springer (2000).

St Thomas College Palai Autonomous

Programme	**BSc (Hons) Physics**					
Course Name	**Mathematical Physics**					
Type of Course	**DCC**					
Course Code	**24U7PHYDCC401**					
Course Level	**400**					
Course Summary	This Mathematical Physics course offers a comprehensive study of complex analysis, Fourier series and transforms, special functions and series solutions of ordinary differential equations, providing students with essential mathematical tools for tackling intricate problems in diverse domains of Physics.					
Semester	**7**	**Credits**			**4**	**Total Hours**
Course Details	**Learning Approach**	**Lecture**	**Tutorial**	**Practical**	**Others**	
		4	**0**	**0**	**0**	**60**
Pre-requisites, if any	**Nil**					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	To analyse complex numbers and functions, using techniques of contour integration and residue theory.	A, An	1,2
2	To gain the ability to represent periodic functions using Fourier series, including determining coefficients and applying Fourier transforms.	U	1,2
3	To apply the Fourier transforms in the Problems related to Physics	A	1,2
4	To solve ordinary differential equations using power series methods,	A	1,2

5	To investigate differential equations arising in physics by using Special functions	A, An	1,2
6	To solve differential functions by applying eigenvalue methods	A	1,2
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom Transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Complex Analysis**		**15**	
	1.1	Functions of a complex variable, The Cauchy–Riemann relations, Power series in a complex variable, Some elementary functions, Multivalued functions, and branch cuts.	5	1
	1.2	Singularities and zeros of complex functions, Conformal transformations, Complex integrals	4	1
	1.3	Cauchy's theorem, Cauchy's integral formula, Taylor and Laurent series	3	1
	1.4	Residue theorem, Definite integrals using contour integration	3	1
2	**Fourier series and Fourier transforms**		**15**	
	2.1	The Dirichlet conditions, The Fourier coefficients, Symmetry considerations, Discontinuous functions, non-periodic functions	5	2,3
	2.2	Integration and differentiation, Complex Fourier series, Parseval's theorem	4	2,3
	2.3	Fourier transforms-The uncertainty principle; Fraunhofer diffraction; the Dirac δ-function; relation of the δ-function to	6	2,3

		Fourier transforms; Properties of Fourier transforms; odd and even functions;		
3		**Series solutions of ordinary differential equations**	**13**	
	3.1	Second-order linear ordinary differential equations, Ordinary and singular points, Series solutions about an ordinary point, Series solutions about a regular singular point	4	4,5
	3.2	Distinct roots not differing by an integer; repeated root of the indicial equation; distinct roots differing by an integer, Obtaining a second solution	5	4,5
	3.3	The Wronskian method; the derivative method; series form of the second solution, Polynomial solutions	4	4,5
4	**Special Functions**		**17**	
	4.1	Legendre functions/Polynomial, Legendre functions for integer l, Spherical harmonics	4	4,5
	4.2	Bessel functions, General solution for non-integer v; general solution for integer v; Laguerre functions, Hermite functions	4	4,5
	4.3	The Beta and gamma function, and related function	4	4,5
	4.4	Sets of functions, Some useful inequalities, Adjoint, self-adjoint and Hermitian operators, Properties of Hermitian operators, Reality of the eigenvalues; orthogonality of the eigenfunctions; construction of real eigenfunctions	5	6
5	**Teacher Specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Demonstrations, Presentations and Discussions

Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 marks** **Formative assessment** ● Quiz ● Assignments ● Seminar **Summative assessment** ● Written tests
	B. End Semester Examination (ESE) **Total: 70 marks, duration 2 hrs** ● Short answer type questions: Answer any 10 questions out of 12(10*3=30) ● Short essay type questions: Answer any 4 questions out of 6(4*7=28) ● Essay type questions: Answer any 1 question out of 2(1*12=12)

Textbook

1. Bence, S. J., K. F. Riley, and M. P. Hobson. "Mathematical methods for physics and engineering." (2006).

References

1. Arfken, George B., Hans J. Weber, and Frank E. Harris. *Mathematical methods for physicists: a comprehensive guide*. Academic press, 2011.
2. Riley, Kenneth Franklin, and Michael Paul Hobson. Foundation mathematics for the physical sciences. Cambridge University Press, 2011.
3. Riley, K. F., and M. P. Hobson. Essential Mathematical Methods for the Physical Sciences. Cambridge: Cambridge UP, 2011. Print.

St Thomas College Palai Autonomous

Programme	**BSc (Hons) Physics**					
Course Name	**Electrodynamics**					
Type of Course	**DCC**					
Course Code	**24U7PHYDCC402**					
Course Level	**400**					
Course Summary	This is an advanced course of Electrodynamics and gives an overview of origin, propagation and applications of Electromagnetic waves. This course also allows the students to gain an understanding of radiation from localized time varying electromagnetic sources. It also helps the students to analyse different phenomena that involve relativistic electrodynamics.					
Semester	7	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre-requisites, if any	Students should be familiar with Maxwell's equations and basic understanding of the Special Theory of Relativity					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	To describe the nature of electromagnetic waves and its propagation through different media including linear isotropic dielectric & conducting media, through different interfaces and hollow metallic waveguides	U	1,2
2	To solve the problem on gauge transformations in Electrodynamics	U, A	1,2
3	To predict radiation from arbitrary distribution of charges including oscillating electric dipoles, oscillating magnetic dipoles and accelerating point charges	U, A, An	1,2

4	To gain the concepts of relativistic electrodynamics and its applications in branches of Physical Sciences	U	1,2
5	To make use of the special theory of relativity in electrodynamics and present it in tensor notations	U, A, An	1,2
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate I, Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom Transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Special techniques for potentials and EM wave analysis**		**20**	**1**
	1.1	Laplace's equations and Uniqueness theorem	3	1
	1.2	The method of images	3	1
	1.3	Multipole expansion of electric and magnetic potential	3	1
	1.4	Electromagnetic waves, Maxwell's equation in Vacuum, Maxwell's equation in matter	3	1
	1.5	Reflection and transmission at normal incidence - Reflection and transmission at oblique incidence, Absorption and Dispersion	4	1
	1.6	Guided waves – waves between parallel conducting plane TE, TM and TEM waves	2	1
	1.7	TE and TM Waves in Rectangular waveguides	2	1
2	**Electromagnetic radiation**		**20**	
	2.1	Potential formulation of electrodynamics. Gauge transformations-Coulomb and Lorentz gauge	3	2,3
	2.2	Continuous charge distribution-Retarded potential-Jefmenko's equation	4	2,3
	2.3	Point charges- Lienard-Wiechert potentials-Field of a point charge in motion- Power radiated by a point charge	4	2,3

	2.4	Electric Dipole Radiation, Magnetic Dipole Radiation	3	2,3
	2.5	Radiation from arbitrary distribution of charges	3	2,3
	2.6	Radiation reaction-Abraham-Lorentz formula	3	2,3
3	**Relativistic Electrodynamics**		**20**	
	3.1	Relativistic electrodynamics	2	4,5
	3.2	Structure of spacetime- Four vectors-Proper time and proper velocity	2	4,5
	3.3	Relativistic energy and momentum, Relativistic dynamics, Minkowski force	4	4,5
	3.4	Magnetism as a relativistic phenomenon	2	4,5
	3.5	Transformation of the fields, Electromagnetic field tensor	4	4,5
	3.6	Electrodynamics in tensor notation	3	4,5
	3.7	Potential formulation of relativistic electrodynamics.	3	4,5
4	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, Demonstration, Assignments, Discussion
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 marks** **Formative assessment** ● Quiz ● Assignments ● Seminar **Summative assessment**

	- Written tests
	B. End Semester Examination **Total: 70 marks, duration 2 hrs** - Short answer type questions: Answer any 10 questions out of 12(10*3=30) - Short essay type questions: Answer any 4 questions out of 6(4*7=28) - Essay type questions: Answer any 1 question out of 2(1*12=12)

Textbook

1. Introduction to Electrodynamics, David J Griffiths, PHI Learning,2009
2. Electromagnetic waves and radiating systems Edward C Jordan, Keith G Balamin, Prentice Hall India Pvt.Ltd

References

1. Electromagnetics, John D.Kraus, McGraw-Hill International
2. Classical electrodynamics, J.D Jackson, John Wiley & Sons Inc
3. Elements of Electromagnetic, Mathew N.O Sadiku, Oxford University Press
4. Antenna and wave propagation, K.D Prasad, Satyaprakashan, New Delhi
5. Electromagnetism problems with solutions, Ashutosh Pramanik, PHI

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<table>
<tr><td>Programme</td><td colspan="6">BSc (Hons) Physics</td></tr>
<tr><td>Course Name</td><td colspan="6">Nuclear and Particle Physics</td></tr>
<tr><td>Type of Course</td><td colspan="6">DCE</td></tr>
<tr><td>Course Code</td><td colspan="6">24U7PHYDCE400</td></tr>
<tr><td>Course Level</td><td colspan="6">400</td></tr>
<tr><td>Course Summary</td><td colspan="6">This advanced nuclear physics course explores nuclear properties and models, including nuclear angular momentum, parity, electromagnetic moments, and the shell model with its associated collective structures. It delves into nuclear reactions, covering reaction types, conservation laws, energetics, and the mechanisms of direct and compound-nucleus reactions. Additionally, the course addresses nuclear astrophysics, focusing on stellar nucleosynthesis, elementary particles, fundamental interactions, and recent experimental advancements such as the Higgs boson and gravitational wave detection.</td></tr>
<tr><td>Semester</td><td>7</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>4</td><td>0</td><td>0</td><td>0</td><td>60</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">Introduction to nuclear physics</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains***	**PO No**
1	To gain knowledge about the fundamental properties of nuclei and details of popular nuclear models	U	1,2
2	To make use of the laws of nuclear decay for better understanding of related nuclear reaction dynamics	U,A	1,2
3	To explain primordial and stellar nucleosynthesis in astrophysical contexts and recent advances in High Energy Physics	U	1,2
4	To apply principles of nuclear physics in Medical Physics in analysing the practical implications	U,A	1,2

5	To familiarise the basic forces, fundamental interactions and their mediators and the classification of elementary particles	U	1,2
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	**Units**	**Course description**	**Hrs**	**CO No.**
1	**Nuclear Properties and Models**		**15**	
	1.1	Nuclear angular momentum and parity; Nuclear electromagnetic moment quadrupole moment, the deuteron-binding energy, spin, parity.	3	1
	1.2	Magnetic moment and electric quadrupole moment, nucleon-nucleon scattering; proton-proton and neutron-neutron interactions, properties of nuclear forces, exchange force model.	4	1
	1.3	Shell Model-Shell model potential, Spin-orbit potential, magnetic dipole moments,	4	1
	1.4	Electric quadrupole moments, Valence Nucleons, Collective structure- nuclear vibrations, nuclear rotations.	4	1
2	**Nuclear Reactions**		**15**	
	2.1	Types of reactions and conservation laws, energetics of nuclear reactions, isospin, nuclear scattering, Compound-nucleus reactions	5	2
	2.2	Reaction cross sections, Coulomb scattering- Rutherford formula	3	2
	2.3	Scattering and reaction cross sections in terms of partial wave amplitudes	5	2
	2.4	Direct reactions, resonance reactions.	2	2
3	**Nuclear Astrophysics**		**15**	

	3.1	Particle and nuclear interactions in the early universe, primordial nucleosynthesis, Stellar nucleosynthesis (for both A<60 and A>60)	5	3
	3.2	Higg's boson and the LHC experiments; detection of gravitational waves and LIGO (qualitative ideas only)	5	3
	3.3	Rutherford Backscattering spectroscopy and applications, Computerized Axial Tomography (CAT), Positron Emission Tomography (PET)	5	4
4	**Elementary particles and their interactions**		**15**	
	4.1	Elementary particles, quantum numbers, fundamental interactions and their mediators,	4	5
	4.2	Classification of elementary particles	4	5
	4.3	Quark hypothesis, hadron multiplets and SU(3) symmetry.	4	5
	4.4	Quantum chromodynamics, Weak interactions and symmetry violations.	3	5
5	**Teacher Specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Demonstrations, Presentations, discussions
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 marks** **Formative assessment** • Quiz • Assignments • Seminar

	Summative assessment ● Written tests
	B. End Semester Examination (ESE) **Total:70 marks, duration 2 hrs** ● Short answer type questions: Answer any 10 questions out of 12(10*3=30) ● Short essay type questions: Answer any 4 questions out of 6(4*7=28) ● Essay type questions: Answer any 1 question out of 2(1*12=12)

Textbook

1. Introductory Nuclear Physics, K. S. Krane John Wiley.
2. Nuclear Physics, S.N. Ghoshal, S. Chand & Company.

References

1. Nuclear Physics: Problem-based Approach Including MATLAB, Hari M Agarwal, PHI Learning Private Limited, Delhi.
2. D. Griffiths, Introduction to Elementary Particles (Wiley, 1987)

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<table>
<tr><td>Programme</td><td colspan="6">BSc (Hons) Physics</td></tr>
<tr><td>Course Name</td><td colspan="6">Radiation Physics</td></tr>
<tr><td>Type of Course</td><td colspan="6">DCE</td></tr>
<tr><td>Course Code</td><td colspan="6">24U7PHYDCE401</td></tr>
<tr><td>Course Level</td><td colspan="6">400</td></tr>
<tr><td>Course Summary</td><td colspan="6">This course provides a comprehensive understanding of radiation sources, including types of ionising and non-ionizing radiations, electromagnetic particles, and various sources such as radioactive materials, accelerators, cyclotrons, and nuclear reactors. Students explore the interaction of radiation with matter, covering topics like inelastic collisions, energy loss, and interaction mechanisms for electrons, heavy charged particles, gamma rays, and neutrons. The course also delves into radiation quantities, units, and dosimeters, discussing particle flux, curie, becquerel, absorbed dose, biological effectiveness, and various dosimeter types. Furthermore, it addresses biological effects of ionizing radiation at molecular, cellular, and genetic levels, emphasizing applications in cancer therapy, food preservation, and sterilisation. The course concludes with radiation protection, shielding methods, and transport considerations for medical, industrial, and research facilities.</td></tr>
<tr><td>Semester</td><td>7</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>4</td><td>0</td><td>0</td><td>0</td><td>60</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">Nil</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains***	**PO No**
1	To understand the different sources of radiation and differentiate the	U	1

	different categories of the same.		
2	To analyse the scientific concept behind the working of different types of accelerators.	U, An, A	1,2
3	To develop an insight into the interaction between radiations and matter and to understand the related scientific terms involved in defining the interaction process.	U, An	1,2,3
4	To introduce the different scientific measurement terms used in the measurement related to radiation.	U, A	1,2
5	To familiarise the different experimental setups used in radiation measurement and differentiate them.	U, An	1,2,3
6	To make aware of the biological effects of radiation and the safety measures for radiation exposure on living organisms.	U, An, A	3,7,8
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom Transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Radiation source**		**14**	
	1.1	Types of radiations, ionizing, non ionizing, electromagnetic, particles, neutral -gamma-neutrino-neutron, charged alpha, beta, gamma, and heavy ion sources	7	**1**
	1.2	radioactive sources - naturally occurring production of artificial isotopes, accelerators-cyclotrons, nuclear reactors.	7	**2**
2	**Interaction of radiations with matter**		**15**	

	2.1	Electrons - classical theory of inelastic collisions with atomic electrons, energy loss per ion pair by primary and secondary ionization, specific energy loss, bremsstrahlung, range energy relation, energy and range straggling,	5	3
	2.2	Heavy charged particles - stopping power, energy loss, range and range energy relations, Bragg curve, specific ionization	3	3
	2.3	Gamma rays Interaction mechanism - Photoelectric absorption, Compton scattering, Pair production, gamma ray attenuation, attenuation coefficients, Elastic and inelastic scattering, Cross sections, linear and mass absorption coefficients, stopping power, LET, Neutrons - General properties, fast neutron interactions, slowing down and moderation.	7	3
3	**Radiation quantities, Units and Dosimeters**		**15**	
	3.1	Particle flux and fluence, calculation of energy flux and fluence, curie, becquerel, exposure and its measurements, absorbed dose and its relation to exposure, KERMA, Biological effectiveness, weighting factors, (WR and WT), Equivalent dose, Effective dose	8	4,5
	3.2	Dosimeters, Primary and secondary dosimeters, Pocket dosimeter, Films and solid dosimeter (TLD and RPL), Clinical and calorimetric devices and Radiation survey meter for area monitoring.	7	4,5
4	**Biological effects**		**16**	
	4.1	Basic concepts of cell biology, Effects of ionizing radiations at molecular, sub molecular and cellular levels, secondary effects, free radicals, deterministic effects, stochastic effects	6	6
	4.2	Effects on tissues and organs, genetic effects, Mutation and chromosomal aberrations, applications in cancer therapy, food preservation, radiation and sterilization.	6	6
	4.3	**Radiation protection, shielding and transport: -** Effective radiation protection, need to safeguard against continuing radiation exposure, justification, and responsibility, ALARA, concept of radiologic practice. time distance and shielding, safety specifications	4	6

5	**Teacher Specific content**	

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Demonstrations, Presentations, discussions
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 marks** **Formative assessment** ● Quiz ● Assignments ● Seminar **Summative assessment** ● Written tests
	B. End Semester Examination (ESE) **Total: 70 marks, duration 2 hrs** ● Short answer type questions: Answer any 10 questions out of 12(10*3=30) ● Short essay type questions: Answer any 4 questions out of 6(4*7=28) ● Essay type questions: Answer any 1 question out of 2(1*12=12)

Textbook

1. G. F. Knoll: "Radiation detection and measurement", (John Wiley & sons, Newyork, 2000)
2. K. Thayalan:"Basic radiological physics", (Jaypee brothers medical Publishers, New Delhi, 2003)
3. W.J. Meredith and J.B. Masse: "Fundamental Physics of radiology", (Varghese publishing house, Bombay, 1992)
4. M.A.S. Sherer, P.J. Visconti, E.R Ritenour: "Radiation Protection in medical radiography". (Mosbey Elsevier, 2006)

References

1. Lowenthal G.C and Airey P.L.:" Practical applications of radioactivity and nuclear radiation sources", (Cambridge University Press, 2005.

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Programme	**BSc (Hons) Physics**					
Course Name	**Classical Mechanics II**					
Type of Course	**DCE**					
Course Code	**24U7PHYDCE402**					
Course Level	**400**					
Course Summary	Along with the Classical Mechanics I, this course introduces the most essential techniques to describe classical dynamics of particles and rigid bodies.					
Semester	7	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	**0**	**0**	**0**	**60**
Pre-requisites, if any	Classical Mechanics I					

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	To understand the fundamentals of kinematics of Rigid body system	U	1,2
2	To apply the principles of Eulers equations of motion in Physical problems	U,A	1,2,3
3	To apply the theory of small oscillations in vibrations of atoms in a linear triatomic molecule	U,A	1,2,3
4	To master the concept of canonical transformation and Poisson bracket	A,An.E	1,2,3
5	To comprehend the Hamilton Jacobi method and the concept of action angle variables.	U	1,2

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Kinematics of Rigid Bodies**		**15**	
	1.1	Co-ordinates of a rigid body, Orthogonal transformation, Properties of Transformation matrix	5	1
	1.2	Euler angles, Euler theorem of motion of a rigid body, Infinitesimal rotation, Rate of change of a vector, Coriolis effect	5	1
	1.3	Angular momentum and kinetic energy of motion about a point, Inertia tensor and moment of inertia, Eigenvalues of inertia tensor and principal axis transformation.	5	1
2	**Rigid Body Motion and Oscillations**		**15**	
	2.1	Rigid body problems and Euler's equation of motion, Torque-free motion of a rigid body, Heavy symmetrical top with one point fixed	6	1,2
	2.2	Formulation of the problem, Eigenvalue equation Principal axis transformation	5	1,2
	2.3	Frequencies of free vibrations and Normal coordinates, Free vibrations of a linear triatomic molecule	4	3
3	**Canonical transformations**		**15**	
	3.1	Canonical transformations, Examples, Harmonic Oscillator, Symplectic approach to canonical transformations,	5	4
	3.2	Poisson brackets and canonical invariants, Equations of motion - Infinitesimal canonical transformations - Conservation theorems in terms of Poisson brackets,	5	4
	3.3	Angular momentum Poisson brackets, Liouville's theorem	5	4

4	**Hamilton Jacobi theory**		**15**	
	4.1	Hamilton - Jacobi equation and Hamilton's principal function, H-J equation for harmonic oscillator	4	5
	4.2	H-J equation for Characteristic function, Separation of variables in H-J equation, Kepler problem	7	5
	4.3	Action-angle variables for one degree freedom - harmonic oscillator, Adiabatic invariants - harmonic oscillator.	4	5
5	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Demonstrations, Presentations, discussions
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 marks** **Formative assessment** ● Quiz ● Assignments ● Seminar **Summative assessment** ● Written tests
	B. End Semester Examination (ESE) **Total:70 marks, duration 2 hrs** ● Short answer type questions: Answer any 10 questions out of 12(10*3=30) ● Short essay type questions: Answer any 4 questions out of 6(4*7=28) ● Essay type questions: Answer any 1 question out of 2(1*12=12)

Textbook

1. Herbert Goldstein, Charles P.Poole and John Safko : "Classical Mechanics"

References

1. L. D. Landau, E. M. Lifshitz: "Mechanics" (Third edition, Butterworth-Heinemanne, 2005)
2. N.C.Rana and P.S.Joag : "Classical Mechanics" (Tata McGraw Hill, 2011)

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<table>
<tr><td>Programme</td><td colspan="6">BSc (Hons) Physics</td></tr>
<tr><td>Course Name</td><td colspan="6">Research Methodology</td></tr>
<tr><td>Type of Course</td><td colspan="6">DCE</td></tr>
<tr><td>Course Code</td><td colspan="6">24U7PHYDCE403</td></tr>
<tr><td>Course Level</td><td colspan="6">400</td></tr>
<tr><td>Course Summary</td><td colspan="6">This course intends to provide the basic methodology to be followed in Scientific research. This course also provides the methods for data collection and Analysis. The importance of research ethics to be practised in the research is also highlighted here. The various helping tools in computer and internet for the research is also briefed in this course</td></tr>
<tr><td>Semester</td><td>7</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>4</td><td>0</td><td>0</td><td>0</td><td>60</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">Nil</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	To introduce the literature Survey and methodology of Research in Science	K	1
2	To apply the methodology in the data collection and Analysis of data	Re, A	1,2,3
3	To create an authentic scientific paper for Journal or Seminar from the result of analysis	An, C	1,2,3
4	To prepare a project proposal in the proper format	A, C	1,2,3,6
5	To practice the research ethics in our area of research	A	1,2,3,6,

6	To make use of Computer and internet tools in the research	A	1,2,3,9
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Introduction to Research Methodology**		**15**	
	1.1	Types of Research – Selection and Formulation of Research Problem	2	1
	1.2	Need and Features of Research Design: Inductive, Deductive and Development of models	2	1
	1.3	Developing a Research Plan: Exploration, Description, Diagnosis, Experimentation, Determining Experimental and Sample Designs.	4	1
	1.4	Analysis of Literature Review: Primary and Secondary Sources, Web sources	2	1
	1.5	Different Types of Hypothesis, Significance and Development of Working Hypothesis	2	1
	1.6	Research Methods: Scientific method vs Arbitrary Method, Logical Scientific Methods: Deductive, Inductive, Deductive-Inductive, pattern of Deductive – Inductive logical process – Different types of inductive logical method	3	1
2	**Data Collection and Analysis**		**15**	
	2.1	Sources of Data – Primary, Secondary and Tertiary – Types of Data – Categorical, nominal & Ordinal.	3	2
	2.2	Methods of Collecting Data: Observation, field investigations, Direct studies – Reports, Records or Experimental observations.	5	2
	2.3	Sampling methods, Data Processing and Analysis strategies-, Graphical representation, Descriptive Analysis, Inferential Analysis, Correlation analysis, Least square method, Data	7	2

		Analysis using statistical package, Hypothesis, testing, Generalization and Interpretation, Modelling.		
3	**Scientific Writing**		**15**	
	3.1	Structure and components of Scientific Reports, types of Report, Technical Reports and Thesis, Significance	2	3
	3.2	Different steps in the preparation: Layout, structure and Language of typical reports, Illustrations and tables, Bibliography, Referencing and footnotes,	2	3
	3.3	Oral presentation: Planning, Preparation and practice, Making presentation, Use of visual aids, Importance of Effective Communication Conventions and strategies of Authentication – Citation Style - sheet	3	3
	3.4	Preparing Research papers for journals, Seminars and Conferences: Design of paper using TEMPLATE, Calculations of Impact factor of a journal, citation Index, ISBN & ISSN.	4	3
	3.5	Preparation of Project Proposal: Title, Abstract, Introduction, Rationale, Objectives, Methodology, Time frame and work plan, Budget and Justification, References	4	4
4	**Research Ethics and Application of Computer in Research**		**15**	
	4.1	Ethical Issues, Ethical Committees, Commercialization, copyright, royalty	2	5
	4.2	Intellectual Property rights and patent law, Track Related aspects of intellectual property Rights, Reproduction of published material, Plagiarism, Citation and Acknowledgement, Reproducibility and accountability.	5	5
	4.3	MS Office and its application in Research – MS Word, MS PowerPoint and MS Excel	5	6
	4.4	Use of the Internet in Research – Websites, Search Engines, E-journal and ELibrary – INFLIBNET.	3	6
5	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, Presentations, Discussions
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 marks** **Formative assessment** ● Quiz ● Assignments ● Seminar **Summative assessment** ● Written tests
	B. End Semester Examination (ESE) **Total: 70 marks, duration 2 hrs** ● Short answer type questions: Answer any 10 questions out of 12(10*3=30) ● Short essay type questions: Answer any 4 questions out of 6(4*7=28) ● Essay type questions: Answer any 1 question out of 2(1*12=12)

Text Books

1. Kothari, C. R. "Research Methodology: Methods and Techniques 2004." (2004).

Reference

1. Introduction To Research Methodology, Garg, B.L, Kavdia, R.,2002, RBSA Publishers.

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Programme	**BSc (Hons) Physics**					
Course Name	**Biophotonics**					
Type of Course	**DCE**					
Course Code	**24U7PHYDCE404**					
Course Level	**400**					
Course Summary	Biophotonics is a multidisciplinary field where light-based technologies are utilized to reveal biological mechanisms. In addition, the course will teach the principles and applications of bioimaging spectroscopy, and biosensors, as well as summarize recently published progress in the field.					
Semester	7	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre-requisites, if any	Foundations of Photonics					

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	To explain the concepts of and science of interaction of light with cells and tissues	U	1,3
3	To investigate different biomedical imaging techniques and choose suitable techniques for diverse application	A, An	1,2,3
3	To examine different strategies for tissue engineering using light	A	1,2,3
4	To appraise different optical biosensors and its implications	U, An	1,2,3
5	Understand the material properties of photosensitizers used for photodynamic therapy	U	1,2,3
6	To understand the use of different light based biological tools for investigating biological molecules	U	1,2,3
***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)**			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Photobiology**		**15**	
	1.1	Interaction of light with cells and tissues,	6	1
	1.2	Photo-process in Biopolymers- human eye and vision	2	1
	1.3	Photosynthesis	2	1
	1.4	Photo-excitation- free space propagation, optical fibre delivery system, articulated arm delivery, hollow tube wave guides. Optical biopsy.	5	1
2	**Bio-imaging**		**15**	
	2.1	Overview of optical imaging, Kohler illumination, phase contrast microscopy, dark-field and differential interference contrast microscopy,	5	2
	2.2	Fluorescence, confocal and multi-photon microscopy,	3	2
	2.3	Optical Coherence Tomography	2	2
	2.4	FRET imaging, exogenous and endogenous fluorophores as bioimaging probes	5	2
3	**Optical Biosensors**		**15**	
	3.1	Optical Biosensor-Principles –Bio-recognition, optical transduction, Fluorescence and FRET sensing, molecular beacons, optical geometries of bio-sensing, Fiber optic Biosensors	5	4
	3.2	Introduction to Flow Cytometry	2	4
	3.3	Principles of Photodynamic therapy, photo-sensitizers for photodynamic therapy (chemical structures not needed), applications of photodynamic therapy	5	5
	3.4	Tissue engineering and light activation; contouring and restructuring of tissues using laser	3	3
4	**Light based Biological Tools**		**15**	

	4.1	Principles of Laser tweezers and laser scissors, optical trapping using non- Gaussian optical beam,	4	6
	4.2	manipulation of single DNA molecules, molecular motors, laser microbeams for Genomics and Proteomics,	4	6
	4.3	semiconductor Quantum dots for bioimaging, Metallic nano-particles and nano-rods for bio-sensing,	4	6
	4.4	Photonics and biomaterials; bacteria as bio-synthesizers for photonics polymers	3	6
5	**Teacher specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, Presentations, Discussions
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 marks** **Formative assessment** ● Quiz ● Assignments ● Seminar **Summative assessment** ● Written tests
	B. End Semester Examination (ESE) **Total: 70 marks, duration 2 hrs** ● Short answer type questions: Answer any 10 questions out of 12(10*3=30) ● Short essay type questions: Answer any 4 questions out of 6(4*7=28) ● Essay type questions: Answer any 1 question out of 2(1*12=12)

Textbook

1. Prasad, Paras N.. Introduction to Biophotonics. Wiley, 2016.

References

1. Biomedical Photonics Handbook, Second Edition: Fundamentals, Devices, and Techniques. United Kingdom, Taylor & Francis, 2014.

St Thomas College Palai Autonomous

Programme	**BSc (Hons) Physics**					
Course Name	**General Relativity**					
Type of Course	**DCE**					
Course Code	**24U7PHYDCE405**					
Course Level	**400**					
Course Summary	As an introductory course, General Relativity will initiate the learner to understand the description of gravity in terms of curved spaces. The course also serves as an introduction to mathematical techniques of differential geometry that are essential to understand curvature.					
Semester	7	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Equip with techniques of tensor analysis	U An E	1, 2
2	Understand the nature of gravity in terms of geometry	An E	1, 2
3	Analyze physical situations involving gravity	U An	1, 2
4	To enable the pursuit of answers to open questions	An E C	1, 2
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Special relativity and tensor analysis**		**15**	
	1.1	Spacetime diagrams, Construction of another coordinates, Invariance of the interval	2	1
	1.2	Invariant hyperbolae, Time dilation and Length contraction, Lorentz transformation	2	1
	1.3	Definition of a vector, Vector algebra,	2	1
	1.4	The four-velocity, Four-momentum Scalar product	2	1
	1.5	Four-velocity and acceleration, Energy momentum (massive particles and photons)	2	1
	1.6	Metric tensor, Definition of tensors,	1	1
	1.7	(0,1) tensor, (0,2) tensor, Mapping vectors to one forms	2	1
	1.8	(M, N) tensors, Indices, Differentiation of tensors	2	1
2	**Curvature, Curved manifolds**		**15**	
	2.1	Gravitation and curvature	2	2.3
	2.2	Tensor algebra and calculus in polar coordinates	2	2,3
	2.3	Christoffel symbol and metric, Non coordinate basis	2	2,3
	2.4	Differentiable manifolds and tensors, Riemannian manifolds	2	2,3
	2.5	Covariant differentiation, Parallel-transport, geodesics, and curvature	3	2,3
	2.6	The curvature tensor	2	3
	2.7	Bianchi identities: Ricci and Einstein tensors, Curvature in perspective	2	3

3	**Physics in curved spacetime, Einstein equations, Gravitational radiation**		**15**	
	3.1	From differential geometry to gravity	1	3
	3.2	Physics in slightly curved spacetime, Curved intuition, conserved quantities	2	3
	3.3	Purpose of the field equations, Einstein's equations	2	3
	3.4	Einstein's equations for weak gravitational fields, Newtonian gravitational fields	3	3
	3.5	Propagation of gravitational waves	2	3
	3.6	Detection of gravitational waves	2	3,4
	3.6	Generation of gravitational waves, Energy carried away by gravitational waves	3	3,4
4	**Spherical Solutions: Stars, Schwarzchild Black Holes**		**15**	
	4.1	Coordinates for spherically symmetric spacetimes, Static spherically symmetric spacetimes	2	3,4
	4.2	The exterior geometry, The interior structure of the star, Exact interior solutions, Realistic stars and gravitational collapse	3	3,4
	4.3	Trajectories in the Schwarzschild spacetime	3	3,4
	4.4	Nature of the surface r = 2M	3	3,4
	4.5	General black holes, Real black holes in astronomy	4	3,4
5	**Teacher specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Tutorials, Seminars/ Presentations Activities, Practical sessions
Assessment Types	**MODE OF ASSESSMENT**

	A. Continuous Comprehensive Assessment (CCA) **Theory: 30 marks** **Formative assessment** ● Quiz ● Assignments ● Seminar **Summative assessment** ● Written tests
	B. End Semester Examination (ESE) **Total: 70 marks, duration 2 hrs** ● Short answer type questions: Answer any 10 questions out of 12(10*3=30) ● Short essay type questions: Answer any 4 questions out of 6(4*7=28) ● Essay type questions: Answer any 1 question out of 2(1*12=12)

Textbook

1. The first course in general relativity, B. F. Schutz; Cambridge University Press.

Reference

1. Gravitation and Cosmology: Principles and Applications of General Theory of Relativity, Steven Weinberg; John Wiley & Sons.
2. Lecture notes on General Relativity, Sean M. Carroll
3. Classical Theory of Fields, Vol. 2: L. D. Landau and E. M. Lifshitz, Oxford: Pergamon Press.
4. Gravitation, Charles W. Misner, Kip S. Thorne, John A. Wheeler; W. H. Freeman and Company.

SEMESTER 8

St Thomas College Palai Autonomous

Programme	**BSc (Hons) Physics**					
Course Name	**Quantum Mechanics**					
Type of Course	**DCC**					
Course Code	**24U8PHYDCC400**					
Course Level	**400**					
Course Summary	The course focuses on introducing important techniques to study the dynamics of physical systems. Exact and approximate methods to study time independent interactions, techniques to analyze scattering and perturbative approach to time dependent interactions are dealt with.					
Semester	8	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	1	0	75
Pre-requisites, if any	Introduction to Quantum Mechanics					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	To solve stationary state problems using exact and approximate methods	A, An	1, 2
2	To gain knowledge on time independent perturbation theory	U	1,2
3	Gain in depth knowledge on the techniques in scattering	U	1, 2
4	To compute probabilities of time dependent processes	A,An	1, 2
5	To conduct independent investigative study into still open questions	E,C	1,2
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Quantum mechanics in three dimensions**		**19**	
	1.1	Schrodinger Equation in spherical coordinates	2	1,5
	1.2	Hydrogen atom	3	1,5
	1.3	Angular momentum	3	1,5
	1.4	Spin	3	1,5
	1.5	**Practicum** 1. Solve the Schrodinger equation for a particle in a spherically symmetric potential $V(r)$. Consider the separation of variables in spherical coordinates and solve for the radial and angular parts. 2. Implement a simulation to study the radial wave equation for the hydrogen atom. Use the numerical solutions to study and visualize the probability density of the electron in various orbitals (1s, 2s, 2p, etc.).	8	1,5
2	**Time-independent perturbation theory**		**20**	
	2.1	Non-degenerate perturbation theory	3	2
	2.2	Degenerate perturbation theory	3	2
	2.3	Fine structure of Hydrogen: Spin-orbit coupling, Zeeman effect	3	2
	2.4	Variational principle: Theory	3	3,5
	2.5	**Practicum** 1. Obtain the energy of the ground state of a one-dimensional (1D) simple-harmonic oscillator(SHO)using the trial wavefunction $\psi(x) = c\ exp(-\alpha x^2)$, where c is the normalisation constant, α the variational parameter. 2. Estimate the ground state energy of a 1D-SHO using the trial wave function of the form $\psi(x) =$	8	2,3,5

		$C\,exp(-\alpha\lvert x\rvert)$, treating α as a variational parameter.		
3	**Scattering**		**18**	
	3.1	Scattering: introduction	3	3,5
	3.2	Partial wave analysis, Phase shifts	5	3,5
	3.3	Born approximation	3	3,5
	3.4	**Practicum** 1. Calculate the phase shift for a particle scattered by a Yukawa potential $V(r) = -\frac{V_0}{r}exp(-\mu r)$ 2. Apply the Born approximation to find the scattering amplitude for a particle in a Coulomb potential.	7	3,5
4	**Time-dependent process**		**18**	
	4.1	Two level systems	3	2,4,5
	4.2	Emission and absorption of radiation	3	2,4,5
	4.3	Spontaneous emission	3	2,4,5
	4.4	Adiabatic theorem	2	2,4,5
	4.5	**Practicum** 1. Calculate the amplitudes for spontaneous and stimulated emission and obtain the selection rules for spontaneous emission. 2. Calculate the absorption coefficient for a two-level atom interacting with an electromagnetic field.	7	2,4,5
5	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Tutorials, Seminars/ Presentations Activities, Practicum sessions, Discussions
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 marks** **Formative assessment** ● Quiz ● Assignment ● Problem solving skills ● Record ● Seminar **Summative assessment** ● Written test
	B. End Semester Examination (ESE) **Theory: 70 marks, duration 2 hrs** ● Short answer type questions: Answer any 7 questions out of 10(7*2=14) ● Short essay-type questions: Answer any 4 questions out of 6(4*6=24) ● Problem type questions: Answer any 4 questions out of 7(4*5=20) ● Essay type questions: Answer any 1 question out of 2(1*12=12)

Text book

1. D. J. Griffiths, “Introduction to Quantum Mechanics”, Prentice Hall (1995)

References

1. Shankar R. Fundamentals of Physics II – Electromagnetism, Optics, and Quantum Mechanics: (The Open Yale Courses Series)Yale University Press 2019.

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<table>
<tr><td>Programme</td><td colspan="6">BSc (Hons) Physics</td></tr>
<tr><td>Course Name</td><td colspan="6">Condensed Matter Physics</td></tr>
<tr><td>Type of Course</td><td colspan="6">DCC</td></tr>
<tr><td>Course Code</td><td colspan="6">24U8PHYDCC401</td></tr>
<tr><td>Course Level</td><td colspan="6">400</td></tr>
<tr><td>Course Summary</td><td colspan="6">The course delves into both theoretical and experimental aspects, providing a comprehensive understanding of the behavior of matter in condensed phases. This course serves as a good starting point for more advanced condensed matter physics studies.</td></tr>
<tr><td>Semester</td><td>8</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>3</td><td>0</td><td>1</td><td>0</td><td>75</td></tr>
<tr><td>Pre – requisites, if any</td><td colspan="6">Proficiency in topics like quantum mechanics and statistical mechanics beyond introductory levels and thermodynamics may be beneficial.</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Students will acquire a comprehensive understanding of fundamental principles in Wave Diffraction, Reciprocal Lattice, Crystal Symmetry, and Free Electron Fermi Gas, demonstrating the ability to explain the underlying concepts and theories.	U, A, An	1,2
2	Students will critically analyze the relationship between crystal vibrations and thermal properties, examining how vibrational modes influence phenomena such as heat capacity, thermal conductivity, and temperature-dependent material behavior.	U, A, An	1,2
3	Students will apply their knowledge of superconductivity to analyze and solve problems related to superconducting materials, demonstrating	U, A, An, E	1,2,3

	proficiency in predicting superconducting behaviors under varying conditions.		
4	Building on foundational knowledge, students will evaluate the impact of crystal structure, defects, and external factors on optical properties, demonstrating the ability to assess and predict material responses to various optical stimuli.	U, A, An, E	1,2,6
5	Students will critically analyze advanced concepts in the magnetic properties of solids, such as magnetic domains, magnetic anisotropy, and the influence of crystal structure on magnetic behavior.	U, A, An	1,2

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	**Units**	**Course description**	**Hrs**	**CO No.**
1	**Wave Diffraction, Reciprocal Lattice, Crystal Symmetry, and Free Electron Fermi Gas**		**15**	1
	1.1	Diffraction of waves by crystals – Bragg's Law – Scattered wave amplitude – reciprocal lattice vectors – diffraction condition – Laue equations – Ewald construction	3	1
	1.2	Brillouin zones – reciprocal lattice to SC, BCC, and FCC lattices – properties of reciprocal lattice	2	1
	1.3	Diffraction intensity – structure factor and atomic form factor – physical significance	3	1
	1.4	Crystal symmetry – symmetry elements in crystals – point groups, space groups	2	1
	1.5	Free electron gas in three dimensions – Heat capacity of the electron gas – relaxation time and mean free path	2	1
	1.6	Electrical conductivity and Ohm's law – Wiedemann-Franz Lorenz Law – electrical resistivity of metals	3	1
2	**Crystal Vibrations and Thermal Properties**		**15**	2
	2.1	Vibrations of crystals with monatomic basis – First Brillouin zone – Group and Phase Velocity – Two atoms per Primitive Basis (1D)	3	2

	2.2	Quantization of elastic waves – Phonon momentum – Inelastic scattering of phonons	2	2
	2.3	Phonon Heat Capacity – Plank distribution – Density of States in one and three dimensions– Einstein Model for Density of states – Debye model for density of states – Debye T^3 Law	2	2
	2.4	Anharmonic Crystal interactions – Thermal Expansion	1	2
	2.5	Thermal Conductivity – thermal resistivity of phonon gas – Umklapp Processes – Imperfections	2	2
	2.6	Occurrence of superconductivity – Experimental observations – persistent currents – effect of magnetic field – Meissner effect – Type I and type II superconductors.	2	2
	2.7	Isotope effect – entropy – heat capacity and thermal conductivity – Energy gap – Microwave and infrared absorption – Theoretical explanations – penetration depth – Coherence length – London equations	2	2
		Cooper pairs and elements of BCS theory – Giaever tunneling – Josephson effects. Elements of high temperature superconductors – Applications of superconductors	1	3
3	**Optical and Magnetic Properties of Solids**		**15**	4
3	3.1	Plasmon – Polaritons, Electron-Electron Interaction – Electron-Phonon Interaction: Polarons	3	4
	3.2	Optical Processes and Excitions – Optical reflectance – Kramers-Kronig Relations, Excitions – Frenkel excitions – Mott-Wannier excitions	4	4
	3.3	Quantum theory of paramagnetism – Hunds rules – crystal field splitting – spectroscopic splitting factor, Cooling by adiabatic demagnetization – Nuclear Demagnetization	4	5
	3.4	Ferromagnetic order – Curie point and the exchange integral – Temperature dependence of the saturation –Magnetization – Saturation Magnetization at absolute Zero, Magnons – Quantization of spin waves – Thermal excitation of Magnons	4	5
4	**Practical**		**30**	1, 2, 3, 4, 5

	1	Write a simulation to model the resistivity of metals as a function of temperature. Incorporate factors such as impurity scattering and electron-phonon interactions. Analyze the results and compare with experimental resistivity data for different metals.		
	2	Simulate the lifetime of minority carriers in a semiconductor and analyze the impact of different parameters (e.g., doping concentration, temperature) on the minority carrier lifetime. Use numerical methods to solve the relevant equations and visualize the results.		
	3	Develop a program to calculate the thermal conductivity and electrical conductivity of metals. Verify the Wiedemann-Franz Lorenz Law by calculating the Lorenz number. Compare simulation results with theoretical values and experimental data.		
	4	Determination of the Miller indices of crystal planes in a given crystal structure and identify the crystal phase using X-ray diffraction data.		
	5	Bandgap-semiconductor diode		
	6	XRD-Phase diagram determination		
	7	Determination of the crystallite size and lattice strain of a given material using X-ray diffraction (XRD) data. Analyze the broadening of diffraction peaks to extract information about the crystallite size and lattice strain using the Williamson-Hall method.		
	8	Zeeman effect-shift of atomic energy levels		
	9	Band gap and type of optical transition (direct or indirect using Tauc relation) from absorption spectra		
	10	Thermal analysis of materials from experimental data		
	11	Study of Bravais lattices with the help of models		
	12	Thermistor parameters (energy band gap)		
5	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Discussion sessions Online resources for simulations, Problem solving sessions
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 marks** **Formative assessment** ● Quiz ● Assignment ● Seminar **Summative assessment** ● Written test **Practical:15 marks** ● Lab involvement ● Viva
	B. End Semester Examination (ESE) **Theory: 50 marks, duration 1.5 hrs** ● Short answer type questions: Answer any 7 questions out of 10(7*2=14) ● Short essay-type questions: Answer any 4 questions out of 6(4*6=24) ● Essay type questions: Answer any 1 question out of 2(1*12=12) **Practical: 35 marks, duration 2 hrs** ● Lab Exam: 30 marks ● Record: 5 marks

Text book

1. Kittel, C. (2004). *Introduction to Solid State Physics* (8th ed.). Wiley India Pvt. Ltd.
2. Wahab, M. A. (2008). *Solid State Physics*. Narosa Publishing House.
3. Omar, M. A. (1999). *Elementary Solid-State Physics*. Pearson India.
4. Puri, & Babbar. *Solid State Physics*. S. Chand.
5. X ray diffraction-A practical approach: C Suryanarayanan, M Grant Norton; Springer
6. Practical Physics: D Chattopadhyay, P C Rakshit: New Central book Agency
7. Advanced Practical Physics: Chauhan Singh: Pragati Prakashan

References

1. Azaroff, Leonid V. *Introduction to Solids*, Tata Mc-Graw Hill, 2004.
2. Ashcroft, N.W., and Mermin, N.D. *Solid State Physics*, Cengage Learning, 1976.
3. Pillai, S.O. *Solid-state Physics*, New Age International Private Limited.
4. Ibach, H., and Luth, H. *Solid-state Physics*, Springer, 2009.

St Thomas College Palai Autonomous

Programme	**BSc (Hons) Physics**					
Course Name	**QUANTUM FIELD THEORY**					
Type of Course	**DCE**					
Course Code	**24U8PHYDCE400**					
Course Level	**400**					
Course Summary	To introduce quantum field theory and its techniques so as to enable the student to take up independent study of advanced techniques as well as research in high energy physics, statistical mechanics, condensed matter physics and various newly emerging applications					
Semester	8	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	1	0	75
Pre-requisites, if any	Nil					

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Understand the principles of classical physics for continuous systems such as fields	U	1,2
2	Recognize and utilize the symmetries of a system in describing the classical dynamics of continuous systems	U,A	1,2
3	Understand the principles of quantum physics for fields	U	1,2
4	Apply techniques of perturbation using Feynman diagrams to describe interactions of fields	U,A	1,2
5	Equip with the techniques to calculate correlators and S-matrix	A,An,E	1,2
6	Develop a comprehensive understanding of Phi-4 interaction of scalar field	A,An,E	1,2

7	Gain a firm foundation for the study of gauge interactions, especially quantum electrodynamics	U	1,2
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Classical fields**		**19**	
	1.1	Lagrangian, symmetries, gauge fields, Real scalar – variational principle, Noether theorem.	3	1, 2
	1.2	Complex scalar field, Electromagnetic field, Yang-Mills field, Maxwell and Proca equations, Canonical quantization	3	1, 2
	1.3	Klein-Gordon field as Harmonic Oscillators, Klein-Gordon field in space-time, Lorentz invariance in wave equations	2	1, 2
	1.4	Dirac equation, Free particle solutions, Dirac Matrices, Dirac Field Bilinears, Quantization of Dirac field, Discrete Symmetries of Dirac Theory	3	1, 2
	1.5	**Practicum** (Problems)	8	1, 2
2	**Interactions**		**18**	
	2.1	Perturbation theory	2	3,4
	2.2	Perturbation Expansion of Correlation Functions	3	3,4
	2.3	Wick's Theorem, Feynman diagrams.	3	3,4
	2.4	Feynman rules for Fermions.	3	3,4
	2.5	**Practicum** (Problems)	7	3,4
3	**Path integral formulation of perturbation theory**		**18**	
	3.1	Path integral formulation, Perturbation theory and S-matrix	2	4,5

	3.2	Coulomb scattering, Functional calculus and properties of path integrals	3	4,5
	3.3	Generating functional for scalar fields - functional integration	3	4,5
	3.4	Free particle Green's functions, Generating functional for interacting fields.	3	4,5
	3.5	**Practicum** (Problems)	7	4,5
4	**S-matrix, Renormalization, Faddeev-Popov method**		**20**	
	4.1	Phi-4 Theory, Generating functional for connected diagrams	3	5,6
	4.2	S-matrix and reduction formula	3	5,6
	4.3	Divergences in Phi-4 theory, Dimensional regularization of Phi-4 theory, Renormalization of Phi-4 theory	3	5,6
	4.4	Faddeev-Popov quantization, Feynman rules for QED, Ward- Takahashi identity.	3	6,7
	4.5	**Practicum** (Problems)	8	5,6,7

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Tutorials, Discussions
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 marks** **Formative assessment** • Quiz • Two Assignments • Seminar • Worksheets **Summative assessment**

	● Written tests
	B. End Semester Examination **Theory: 70 marks** Written exam – 2hrs ● Short answer type questions: Answer any 7 questions out of 10(7*2=14) ● Short essay-type questions: Answer any 4 questions out of 6(4*6=24) ● Problem type questions: Answer any 4 questions out of 7(4*5=20) ● Essay type questions: Answer any 1 question out of 2(1*12=12)

Textbooks

1. Quantum Field Theory, Lewis H Ryder, 2nd Edn, Cambridge University Press (1996).
2. An Introduction to Quantum Field Theory, Michael E Peskin, Daniel V Schroeder, Westview (1995).

References

1. Critical Properties of Phi-4 Theories, Hagen Kleinert, Verena Schulte- Frohlinde, World Scientific (2001)
2. Introduction to Quantum Field Theory, Horatiu Nastase, Cambridge University Press (2020).
3. Field theory: A Modern Primer, P Ramond, Benjamin-Cummins Publishing Co (1981)
4. Relativistic Quantum Fields, J D Bjorken and S D Drell, McGraw Hill Company
5. The Quantum Theory of Fields, Steven Weinberg, Cambridge University Press.
6. Introduction to the Theory of Quantized Fields, N N Bogoliubov, D V Shirkov New York, (1959)
7. Quantum Field Theory, C Itzykson, J-B Zuber, McGraw Hill Inc (1980).
8. Quantum Field Theory, M Srednicki, Cambridge University Press (1996)
9. Classical FIeld Theory, Horatiu Nastase, Cambridge University Press

St Thomas College Palai Autonomous

Programme	**BSc (Hons) Physics**					
Course Name	**Nonlinear Dynamics**					
Type of Course	**DCE**					
Course Code	**24U8PHYDCE401**					
Course Level	**400**					
Course Summary	This course delves into nonlinear dynamics, teaching students to model systems, understand complex behaviors, and apply computational techniques for analyzing real and synthetic data.					
Semester	8	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	1	0	75
Pre-requisites, if any	Basics of Mechanics and Calculus.					

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	To understand the basic idea behind the phase -plane analysis	U	1,2
2	To distinguish between regular and chaotic motion	U,An	1,2
3	To explain the control and synchronisation of chaos	U	1,2
4	To analyse the linear propagation of dispersive and nondispersive waves and	U.An	1,2
5	To make use of numerical techniques in solving the problems in Nonlinear dynamics	A,An.E	1,2
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom Transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Trajectories in Phase Plane**		**12**	
	1.1	Phase Plane Analysis, Phase Portraits	2	1
	1.2	Existence and Uniqueness Theorem, Fixed Points and Linearization- Rabbits versus Sheep	5	1
	1.3	Conservative Systems, Reversible Systems Pendulum.	5	1
2	**Characterization of Motion**		**15**	
	2.1	Characterization of Regular and Chaotic Motions, Lyapunov Exponents, Numerical Computation of Lyapunov Exponents	5	2
	2.2	Power Spectrum, Autocorrelation,	4	2
	2.3	Hausdorff Dimension, Correlation Dimension, Criteria for Chaotic Motion	6	2
3	**3.1 Control and Synchronization**		**18**	
	3.1.1	Controlling of Chaos, Controlling and Controlling Algorithms,	3	3
	3.1.2	Synchronization of Chaos, Chaotic Cryptography. Time Series Analysis	4	3
	3.1.3	Embedding Dimension, Largest Lyapunov Exponent	3	3
	3.2	**Dispersive and Non-Dispersive Waves**		
	3.2.1	Linear Nondispersive Wave Propagation, Linear Dispersive Wave Propagation	3	4
	3.2.2	Korte Weg-de Vries Equation - Solitary Waves	3	4
	3.2.3	Solitons (Qualitative)	2	4
4	**Practicals**		**30**	

	4.1	Using numerical techniques, simulate the dynamics of rabbits and sheep.		5
	4.2	Using numerical techniques, simulate the dynamics of a prey-predator system		5
	4.3	Obtain the phase plot of a pendulum.		5
	4.4	Compare the power spectra of nonlinear oscillators in the periodic and chaotic regime.		5
	4.5	Obtain the Lyapunov exponent spectrum of a chaotic attractor.		5
	4.6	Using any chaotic system, demonstrate the synchronization of chaotic systems.		5
	4.7	Using any chaotic system, demonstrate chaotic encryption.		5
	4.8	Using techniques suggested in textbooks or any other method, demonstrate controlling chaos.		5
	4.9	Using *time-delay embedding*, find the largest Lyapunov exponent of a Lorentz attractor.		5

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Tutorials, Seminars/ Presentations Practical sessions
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 marks** **Formative assessment** ● Quiz ● Assignment ● Seminar **Summative assessment** ● Written test

	Practical: 15 marks ● Lab involvement ● Viva
	B. End Semester Examination (ESE) **Theory: 50 marks, duration 1.5 hrs** ● Short answer type questions: Answer any 7 questions out of 10(7*2=14) ● Short essay-type questions: Answer any 4 questions out of 6(4*6=24) ● Essay type questions: Answer any 1 question out of 2(1*12=12) **Practical: 35 marks, duration 2 hrs** ● Lab Exam:30 marks ● Record: 5 marks

Textbook

1. Nonlinear Dynamics and Chaos, Steven Strogatz, CRC Press. [for module 1]
2. Nonlinear Dynamics Integrability, Chaos and Patterns, M. Lakshmanan and S. Rajasekar, Springer. [for modules 2 and 3]

References

1. Deterministic Chaos, N. Kumar, Universities Press.
2. Chaos and Nonlinear Dynamics, RC. Hilborn, Oxford University Press.
3. Chaotic Dynamics: An Introduction, G.L. Baker, and J.P. Gollub, CUP, 1993.
4. Chaos in Dynamical System, E. Ott, Cambridge University Press.
5. S. Neil Rasband, Chaotic Dynamics of Nonlinear Systems, Courier Dover Publications

St Thomas College Palai Autonomous

Programme	**BSc (Hons) Physics**					
Course Name	**Introduction to Quantum Computation and Information Theory**					
Type of Course	**DCE**					
Course Code	**24U8PHYDCE402**					
Course Level	**400**					
Course Summary	This course in "Introduction to Quantum Computation and Information Theory" explores the fundamentals of quantum mechanics, quantum algorithms, communication protocols, and quantum information theory. Through theoretical insights and hands-on experience with quantum computers, students will delve into this emerging field of research, gaining a deeper understanding of quantum phenomena and their transformative potential in computing and communication technologies.					
Semester	**8**	Credits			**4**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	**1**	0	**75**
Pre-requisites, if any	Introductory level knowledge in Quantum Mechanics					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	**Remember** the foundational principles of quantum mechanics, such as linear vector spaces and the postulates of quantum mechanics	K	1,2
2	**Understand** quantum gates, entanglement and algorithms, explaining how these concepts contribute to the computational power of quantum systems.	U	1,2
3	**Apply**: Through practical exercises and tutorials, students will apply quantum algorithms to solve computational problems.	A	1,2
4	**Analyze**: Students will analyze quantum communication protocols and error correction techniques to identify potential improvements or limitations.	An	1,2

5	**Design** quantum circuits using various quantum gates and demonstrate the **creation** of different quantum states.	C	1,2
6	**Implement: (Skill)** Gain hands-on experience **in a quantum** computing platform like IBM Quantum Composer.	A, S	1,2
7	**Evaluate** experimental implementations of quantum circuits and gain insight into the practical challenges in realizing quantum technologies.	E	1,2
8	Students will **appreciate** the power of quantum algorithms and the concept of generalized measurements, which go beyond the standard projective measurements in quantum mechanics	Ap	1,2
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transactions (Units)

Module	**Units**	**Course description**	**Hrs**	**CO No.**
1	**Review of Quantum Mechanics**		**10**	
	1.1	Linear vector space – Dirac notation- linear independence – inner product – Cauchy Schwarz inequality – Gram Schmidt decomposition.	3	1, 2
	1.2	Linear operators - Matrix representation - Pauli matrices- Projectors - Eigen values and Eigen vectors – Hermitian operators - Unitary operator – Change of basis - tensor product	4	1, 2
	1.3	Postulates of quantum mechanics – The EPR Paradox and Bell's theorem.	3	1, 2
2	**Introduction to Quantum Algorithms**		**17**	
	2.1	Qubit – Bloch Sphere– Measuring the state of a qubit	2	1, 2
	2.2	Introduction to Classical Computation	1	1, 2
	2.3	The circuit model of quantum computation - Quantum gates: Single-qubit gate, rotations of the Bloch Sphere	3	2, 3

	2.4	Controlled gates – Entanglement generation – The Bell basis - Universal quantum gates	3	3, 8
	2.5	Function evaluation - Deutsch's algorithm – The Deutsch Joza algorithm	4	2, 4, 8
	2.6	The quantum Fourier transform - Quantum phase estimation.	4	2, 4, 8
3	**Quantum Communication & Quantum Information Theory**		**18**	
	3.1	Introduction to classical cryptography – Vernam cipher – public-key cryptosystem	3	2, 7, 8
	3.2	Quantum no-cloning theorem – QKD protocols: BB84, E91	4	2, 4, 7, 8
	3.3	Dense coding – Quantum teleportation	2	2, 3
	3.4	The density matrix - composite systems– Schmidt decomposition	4	1, 2
	3.5	Measurement of the density matrix for a qubit – generalized measurements - weak measurements	4	1, 2
	3.6	Shannon entropy – Von Neuman entropy	1	1, 2
4	**Practicum**		**30**	
	1	Understand the representation of various quantum states of a qubit in Bloch sphere representation.	2	2
	2	Learn about projective measurement, which extracts information from quantum states while altering their original configuration.	2	2
	3	Learn about tensor products, which is essential for understanding composite quantum systems and their states.	2	2, 3
	4	Explore quantum gates and circuits with the IBM Quantum Composer.	2	3, 5, 6, 7
	5	Design quantum circuits that create different entangled states: Bell, three- and four-qubit GHZ, and four-qubit cluster states.	2	3, 5, 6, 7
	6	Construct a quantum circuit implementing the addition of two n-bit integers *a* and *b* (quantum adder circuit).	2	3, 5, 6, 7
	7	Explore the game of prisoner's dilemma with quantum rules.	2	3, 4, 8

	8	Explore the Bernstein-Vazirani algorithm for finding hidden binary strings or Shor's algorithm for factoring large integers, showcasing the advantages of quantum computation.	2	3, 5, 6, 7
	9	Study quantum circuits used for the implementation of 2-qubit, 3-qubit, and 4-qubit Grover's algorithm in the available quantum computers.	4	3, 5, 6, 7
	10	Design and implement a quantum circuit that achieves quantum teleportation	2	3, 5, 6
	11	Design and implement a quantum circuit that achieves entanglement swapping.	2	3, 5, 6
	12	Explore the concept of partial trace and reduced density operators, pivotal tools in quantum mechanics for extracting information about subsystems from composite quantum systems.	2	2, 4, 7, 8
	13	Explore the three-qubit bit-flip code, a key technique for correcting bit-flip errors in quantum information.	2	2, 4, 7, 8
	14	Learn the three-qubit phase-flip code, an essential technique for correcting phase-flip errors in quantum information.	2	2, 4, 7, 8

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Demonstrations, Presentations and Discussions
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 25 marks** **Formative assessment** ● Quiz ● Assignment ● Seminar ● Course project ● Project presentation **Summative assessment** ● Written test **Practical:15 marks** ● Lab involvement ● Viva

	B. End Semester Examination (ESE) Written examination **Theory: 50 marks, duration 1.5 hrs** ● Short answer type questions: Answer any 7 questions out of 10(7*2=14) ● Short essay-type questions: Answer any 4 questions out of 6(4*6=24) ● Essay type questions: Answer any 1 question out of 2(1*12=12) **Practical: 35 marks, duration 2 hrs** ● Lab Exam: 30 marks ● Record: 5 marks

Textbook:

1. Principles of Quantum Computation and Information (**Vol: I**) by Giuliano Benenti, Giulio Casati, Giuliano Strini (Publisher: World Scientific)
2. Principles of Quantum Computation and Information (**Vol: II**) by Giuliano Benenti, Giulio Casati, Giuliano Strini (Publisher: World Scientific)

Books for Additional Reading:

1. Quantum computation and quantum information by Michael A. Nielsen and Issac L. Chuang
2. Quantum Computer Science: An Introduction by N. David Mermin, Cambridge University Press.
3. Lecture notes of Physics 219: Quantum Computation by John Preskill, http://theory.caltech.edu/~preskill/ph229/
4. An Introduction to Quantum Computing by Phillip Kaye, Raymond Laflamme and Michele Mosca, Oxford University Press.
5. Introduction to Quantum Information Science by Vlatko Vedral
6. Quantum Computing Explained by David McMahon

St Thomas College Palai Autonomous

Programme	**BSc (Hons) Physics**			
Course Name	**INTERNSHIP**			
Type of Course	**INT**			
Course Code	**24U4PHYINT200**			
Semester	4	Credits	2	

INTERNSHIP

The internship program aims to provide undergraduate students with practical experience in a professional setting related to their field of study. Through this program, students will enhance their skills in experimental techniques, data analysis, and scientific communication, gain practical knowledge, and establish valuable connections in the industry or research sector. To foster collaboration between academic institutions and industries/research organizations and also to provide students with practical exposure to real-world applications of physics concepts.

The internship program will have a minimum duration of 60 hours. Internships will commence after the completion of the fourth semester and must conclude before the commencement of the fifth semester. Assessment of the internship program will be based on the following criteria: Completion of assigned tasks and projects. Quality of the internship report submitted by the student. Feedback from the hosting organisation and the faculty mentor. supervisor feedback, demonstration of skills acquired, and overall contribution to the internship organisation.

Internship Evaluation (Total 50 marks)

1	**Continuous Comprehensive Assessment (CCA)- 15 marks**	
	Internship Supervisor feedback	10
	Feedback from the hosting organisation	5
2	**End Semester Examination (ESE)- 35 marks**	

	Internship Report	10
	Presentation	15
	Viva Voice	10

St Thomas College Palai Autonomous

Programme	**BSc (Hons) Physics**			
Course Name	**Project (Honours/ Honours with Research)**			
Type of Course	**PRJ**			
Course Code	**24U8PHYPRJ400**			
Course Level	**400**			
Semester	8	Credits	12	

PROJECT

Project work/Dissertation is considered as a special course involving the application of knowledge in solving/analyzing/exploring a real-life situation / difficult problem. It typically involves independent research and critical analysis. The project or dissertation can be worth 12 credits. This credit allocation reflects the amount of effort and time expected from students.

Research Project of Honours with Research: 200 Mark			
1	**Continuous Comprehensive Assessment (CCA) : 60 mark**		
	1	Synopsis Presentation	20
	2	Technical Skill	20
	3	Report & Overall Performance	20
2	**End Semester Examination (ESE): 140 marks**		
	1	Relevance of the topic	30
	2	Review of Literature	10
	3	Methodology	20
	4	Result and Discussion	20
	5	Conclusion	10
	6	Presentation	20

	7	Viva Voce	30

TEACHER SPECIFIC CONTENT

This can be classroom teaching, practical sessions, field visits etc. as specified by the teacher concerned. This content will be evaluated under CCA.

PRACTICALS

A minimum of 6 experiments are to be performed from the course with practical content during a semester.