MAR ATHANASIUS COLLEGE (AUTONOMOUS), KOTHAMANGALAM

NAAC Accredited 'A^{+}' Grade Institution

FOUR YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B Sc (HONOURS) PHYSICS

SYLLABUS

(2024 Admission Onwards)

KOTHAMANGALAM COLLEGE P O - 686666

KERALA, INDIA

Email: mac@macollege.in

www.macollege.ac.in

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PREFACE

The Mar Athanasius College Under Graduate Programme (MAC-UGP Honours) in Physics represents a significant advancement in the higher education landscape of Kerala. This innovative programme not only offers a comprehensive academic foundation but also opens up a myriad of career opportunities for students. We have meticulously redesigned the conventional curriculum to prioritize student engagement and cater to individual learning paths.

MAC-UGP in Physics begins with a broad introductory course that establishes a robust framework for advanced studies in Physics. Students benefit from the flexibility to choose their major at the end of their first year and can select minors aligned with their interests. The curriculum has been updated to include courses in Computational Physics, Electronics and Sustainable Materials, addressing the current demands of industries and companies.

In addition to foundational and advanced Physics courses, students are exposed to cutting-edge areas of the field, providing them with the knowledge necessary for further academic pursuits and research. The programme also emphasizes practical learning through a hands-on approach, ensuring students are equipped with the latest tools and methodologies to tackle complex physics problems. During the fourth semester, students have the opportunity to participate in internships, bridging the gap between academia and industry. This exposure not only enhances their understanding of real-world applications but also fosters valuable industry connections.

At MAC-UGP, our teaching philosophy revolves around activity-based pedagogy, where practical sessions complement theoretical learning, creating a well-rounded educational experience. Students opting for Honours with a research focus have the chance to undertake a significant research project in their fourth year, preparing them for future academic endeavours or professional careers.

We firmly believe that this programme will not only shape our students into scientifically minded individuals but also instill in them a sense of humanism and a commitment to addressing real-world challenges. By nurturing these skills and values, MAC-UGP aims to produce graduates who are well-prepared to make meaningful contributions to society.

MAR ATHANASIUS COLLEGE (AUTONOMOUS), KOTHAMANGALAM

Members of the Board of Studies - UG Programme

Subject: PHYSICS

Chairperson	Dr. Smitha Thankachan Associate Professor of Physics (HOD) Mar Athanasius College, Kothamangalam
Experts (Outside University)	Dr. S. Sankararaman Professor, Department of Opto-Electronics Kerala University, Thiruvananthapuram
	Dr. Riju C Issac Associate Professor Cochin University of Science and Technology, Kochi
***One Expert - nominated by VC (M. G. University)**	Dr. Sivakumar C Associate Professor of Physics, Maharajas College, Ernakulam
Member from Industry	VP Sreekumar General Manager Sayegh Paint Factories India Private Limited (National Paints), XXII/260 A, Angamaly Industrial Area Angamaly South, Ernakulam
Meritorious Alumnus	Dr. Sajimol Augustine M. Administrative Officer and Former Principal St: Teresa's College, Ernakulam
Other Members of the Department	Dr. Benoy M.D. Professor of Physics M A College, Kothamangalam
	Dr. Deepa S Assistant Professor of Physics M A College, Kothamangalam
	Dr. Francis Xavier P. A. Assistant Professor of Physics M A College, Kothamangalam
	Ms. Jassi J. Assistant Professor of Physics M A College, Kothamangalam
	Dr. Saritha K Nair Assistant Professor of Physics M A College, Kothamangalam
	Dr Sanu Mathew Simon Assistant Professor of Physics M A College, Kothamangalam

Graduate Attributes (GA) of the College

The fundamental premise underlying the learning outcomes-based approach to curriculum planning and development is that higher education qualifications are awarded on the basis of demonstrated achievement of outcomes (expressed in terms of knowledge, understanding, skills, attitudes and values) and academic standards expected. The expected learning outcomes are used as reference points that would help formulate graduate attributes, qualification descriptors, programme outcomes and course outcomes which in turn will help in curriculum planning and development, and in the design, delivery and review of academic programmes. The graduate attributes of the college are

GA 1: Critical thinking and Analytical reasoning

Capability to analyse and evaluate evidence, arguments, claims, beliefs on the basis of empirical evidence; identify relevant assumptions or implications; formulate coherent arguments; critically evaluate practices, policies and theories to develop knowledge and understanding; critical sensibility to lived experiences, with self-awareness and reflexivity of both self and society.

GA 2: Scientific reasoning and Problem-solving

Ability to analyse, interpret and draw conclusions from quantitative/qualitative data; and critically evaluate ideas, evidence and experiences from an open-minded and reasoned perspective; capacity to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems, rather than replicate curriculum content knowledge; and apply one's learning to real-life situations.

GA 3: Multidisciplinary/interdisciplinary/transdisciplinary Approach

Acquire interdisciplinary/multidisciplinary/transdisciplinary knowledge base as a consequence of the learning they engage with their programme of study; develop a collaborative multidisciplinary/interdisciplinary/transdisciplinary- approach for formulate constructive arguments and rational analysis for achieving common goals and objectives.

GA 4: Intra and Interpersonal skills

Ability to work effectively and respectfully with diverse teams; facilitate cooperative or coordinated effort on the part of a group, and act together as a group or a team in the interests of a common cause and work efficiently as a member of a team; lead the team to guide people to the right destination, in a smooth and efficient way.

GA 5: Digital literacy

Capability to use ICT in a variety of learning situations, demonstrate ability to access, evaluate, and use a variety of relevant information sources; and use appropriate software for analysis of data.

GA 6: Global citizenship and pride in India

Possess knowledge of the values and beliefs of multiple cultures and a global perspective; and capability to effectively engage in a multicultural society and interact respectfully with diverse groups. After the study, the student should possess the rich, diverse, ancient and modern culture and knowledge systems and traditions of Indian culture.

GA 7: Social Competency and constitutional values

Ability to contemplate of the impact of research findings on conventional practices, and a clear understanding of responsibility towards societal needs and reaching the targets for attaining inclusive and sustainable development and to impart constitutional values such as democratic spirit, spirit of service, respect for public property, scientific temper, liberty, responsibility, pluralism, equality, and justice.

GA 8: Equity, Inclusiveness and Sustainability

Appreciate equity, inclusiveness and sustainability and diversity; acquire ethical and moral reasoning and values of unity, secularism and national integration to enable to act as dignified citizens; able to understand and appreciate diversity (caste, ethnicity, gender and marginalization), managing diversity and use of an inclusive approach to the extent possible and a respect for the local context in all curriculum, pedagogy, and policy, always keeping in mind that education is a concurrent subject.

GA 9: Lifelong Learning

Ability to acquire knowledge and skills, including "learning how to learn", that are necessary for participating in learning activities throughout life, through self-paced and self-directed learning aimed at personal development, meeting economic, social and cultural objectives, and adapting to changing trades and demands of work place through knowledge/skill development/reskilling.

Programme Outcomes (PO)

PO 1: Critical thinking and Analytical reasoning

Capability to analyse and evaluate evidence, arguments, claims, beliefs on the basis of empirical evidence; identify relevant assumptions or implications; formulate coherent arguments; critically evaluate practices, policies and theories to develop knowledge and understanding; critical sensibility to lived experiences, with self awareness and reflexivity of both self and society.

PO 2: Scientific reasoning and Problem solving

Ability to analyse, interpret and draw conclusions from quantitative/qualitative data; and critically evaluate ideas, evidence and experiences from an open-minded and reasoned perspective; capacity to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems, rather than replicate curriculum content knowledge; and apply one's learning to real life situations.

PO 3: Multidisciplinary/interdisciplinary/transdisciplinary Approach

Acquire interdisciplinary /multidisciplinary/transdisciplinary knowledge base as a consequence of the learning they engage with their programme of study; develop a collaborative-multidisciplinary/interdisciplinary/transdisciplinary- approach for formulate constructive arguments and rational analysis for achieving common goals and objectives.

PO 4: Communication Skills

Ability to express thoughts and ideas effectively in writing and orally; Communicate with others using appropriate media; confidently share one's views and express herself/himself; demonstrate the ability to listen carefully, read and write analytically, and present complex information in a clear and concise manner to different groups.

PO 5: Leadership and Entrepreneurship Skills

Ability to work effectively and lead respectfully with diverse teams; setting direction, formulating an inspiring vision, building a team who can help achieve the vision, motivating and inspiring team members to engage with that vision, and using management skills to guide people to the right destination, in a smooth and efficient way. After inculcating all the necessary graduate qualities, a graduate can become an entrepreneur.

PO 6: Social Consciousness and Responsibility

Ability to contemplate of the impact of research findings on conventional practices, and a clear understanding of responsibility towards societal needs and reaching the targets for attaining inclusive and sustainable development.

PO 7: Equity, Inclusiveness and Sustainability

Appreciate equity, inclusiveness and sustainability and diversity; acquire ethical and moral reasoning and values of unity, secularism and national integration to enable to act as dignified citizens; able to understand and appreciate diversity (caste, ethnicity, gender and marginalization), managing diversity and use of an inclusive approach to the extent possible.

PO 8: Moral and Ethical Reasoning

Ability to embrace moral/ethical values in conducting one's life, formulate a position/argument about an ethical issue from multiple perspectives, and use ethical practices in all work. Capable of demonstrating the ability to identify ethical issues related to one's work, avoid unethical behavior.

PO 9: Networking and Collaboration

Acquire skills to be able to collaborate and network with educational institutions, research organisations and industrial units in India and abroad.

PO 10: Lifelong Learning

Ability to acquire knowledge and skills, including "learning how to learn", that are necessary for participating in learning activities throughout life, through self-paced and self-directed learning aimed at personal development, meeting economic, social and cultural objectives, and adapting to changing trades and demands of work place through knowledge/skill development/reskilling.

PROGRAMME OUTCOME AND PROGRAMME SPECIFIC OUTCOME OF FYUGP

PROGRAMME OUTCOMES (PO):

At the end of the programme, the graduate will be able to

No.	Outcome
PO1	Critical thinking and Analytical reasoning
PO2	Scientific reasoning and Problem-solving
PO3	Multidisciplinary/interdisciplinary/transdisciplinary Approach
PO4	Communication Skills
PO5	Leadership and Entrepreneurship Skills
PO6	Social Consciousness and Responsibility
PO7	Equity, Inclusiveness and Sustainability
PO8	Moral and Ethical Reasoning
PO9	Networking and Collaboration
PO10	Lifelong Learning

PROGRAMME SPECIFIC OUTCOMES (PSO):

At the end of the B.Sc. Physics programme the student will be able to:

No.	Outcome	PO-PSO Mapping
PSO1	Demonstrate proficiency in comprehending, solving, and applying major concepts of physics across all disciplines.	1, 2, 3
PSO2	Develop systematic problem-solving skills, think independently and methodically, and draw logical conclusions when addressing physics-related challenges.	1,2,3
PSO3	Apply critical thinking skills and scientific knowledge to effectively design, execute, document, and analyze the outcomes of physics experiments.	1,2,3,5,10
PSO4	Foster an understanding of the societal implications and broader impacts of physics, thereby ensuring sustainable development of the community.	5,6,7,10
PSO5	Attain professional competency in both theoretical and experimental aspects of physics through rigorous training and practical experience.	5,9,10
PSO6	Develop research-oriented skills by handling sophisticated instruments	2,3,10

Syllabus Index

Name of the Major Subject: Physics

Courses which have study tour/field visits/institution visit

SI No	Semester	Course type	Course Title
1	1	MDC	Observational Astronomy
2	4	INT	Internship
3	6	SEC	Basics of AI and Machine Learning

Courses with Practical and Records

SI No	Semester	Course type	Course Title
1	1	DSC	Foundations of Physics
2	1	MDC	Observational Astronomy
3	2	DSC	Modern Physics
4	2	MDC	Physics in Sports
5	3	DSC	Mechanics and Properties of Matter
6	3	DSE	Semiconductor Physics
7	3	DSE	Introduction to Optics
8	3	DSE	C++ for Computational Physics
9	3	DSE	Basic Electronics and Electricity
10	4	DSC	Wave Optics
11	4	DSE	Digital Electronics
12	4	DSE	Laser Physics
13	4	DSE	Numerical Methods for Computational Physics
14	4	DSC	Atomic and Molecular Spectroscopy

16	5	DSE	Material Characterization Techniques
17	5	DSE	Medical Physics
18	5	DSE	Optoelectronics
19	5	DSE	Computational Physics using Python
20	5	DSE	Amplifiers and Oscillators
21	6	DSC	Thermodynamics and Introductory Statistical Mechanics
22	6	DSE	Sustainable Energy Sources
23	6	DSE	Science of Sound
24	6	DSE	Semiconductor Optoelectronic Devices
25	6	DSE	Exploring the Cosmos
26	6	SEC	Basics of AI and Machine Learning
27	7	DCC	Statistical Physics
28	8	DCC	Advanced Quantum Mechanics
29	8	DCC	Condensed Matter Physics
30	8	DCE	Advanced Nuclear and Particle Physics
31	8	DCE	Electronics
32	8	DCE	Microelectronics and Semiconductor Devices
33	8	DCE	Communication Systems

Syllabus Index: Physics Major

Name of the Major Subject: Physics

Semester: 1

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
M24PH1DSC100	Foundations of Physics	DSC A	4	5	3	0	2	0
M24PH1MDC100	Observational Astronomy	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 DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
M24PH2DSC100	Modern Physics	DSC A	4	5	3	0	2	0
M24PH2MDC100	Physics in Sports	MDC	3	4	2	0	2	0

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

Semester: 3

Course Code	Title of the Course		Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
						L	T	P	O
M24PH3DSC200	Mechanics and Properties of Matter		DSC A	4	5	3	0	2	0
M24PH3DSC201	Essential Mathematics for Physics		DSC A	4	4	4	0	0	0
M24PH3DSE200	Semiconductor Physics (Electronics)	Any One	DSE	4	5	3	0	2	0
M24PH3DSE201	Introduction to Optics (Photonics)								
M24PH3DSE202	C++ for Computational Physics (Computational Physics)								
M24PH3DSC202	Basic Electronics and Electricity		DSC B	4	5	3	0	2	0
M24PH3MDC200	Introduction to Medical Physics		MDC	3	3	3	0	0	0
M24PH3VAC200	Science and Society		VAC	3	3	3	0	0	0

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

Semester: 4

Course Code	Title of the Course		Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
						L	T	P	O
M24PH4DSC200	Wave Optics		DSC A	4	5	3	0	2	0
M24PH4DSC201	Electromagnetic Theory		DSC A	4	4	4	0	0	0
M24PH4DSE200	Digital Electronics (Electronics)	Any One	DSE	4	5	3	0	2	0
M24PH4DSE201	Laser Physics (Photonics)								
M24PH4DSE202	Numerical Methods for Computational Physics (Computational Physics)								
M24PH4DSC202	Atomic and Molecular Spectroscopy		DSC C	4	5	3	0	2	0
M24PH4SEC200	Electrical Circuits and network skills		SEC	3	3	3	0	0	0
M24PH4VAC200	Green Energy		VAC	3	3	3	0	0	0
M24PH4INT200	Internship		INT	2					

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

Semester: 5

Course Code	Title of the Course		Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
						L	T	P	O
M24PH5DSC300	Classical and Quantum Mechanics		DSC A	4	4	4	0	0	0
M24PH5DSC301	Elements of Spectroscopy		DSC A	4	4	4	0	0	0
M24PH5DSC302	Nuclear and Particle Physics		DSC A	4	4	4	0	0	0
M24PH5DSE300	Amplifiers and Oscillators (Electronics)	Any two	DSE	4	5	3	0	2	0
M24PH5DSE301	Optoelectronics (Photonics)								
M24PH5DSE302	Computational Physics using Python (Computational Physics)								
M24PH5DSE303	Materials Characterization Techniques (Sustainable Materials)								
M24PH5DSE304	Medical Physics (Biophysics)								
M24PH5SEC300	Research Methodology		SEC	3	3	3	0	0	0

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

Semester: 6

Course Code	Title of the Course		Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
						L	T	P	O
M24PH6DSC300	Solid State Physics		DSC A	4	4	4	0	0	0
M24PH6DSC301	Thermodynamics and Introductory Statistical Mechanics		DSC A	4	5	3	0	2	0
M24PH6DSE300	Nonlinear Optics (Photonics)	Any One	DSE	4	4	4	0	0	0
M24PH6DSE301	Introduction to Low dimensional Materials (Sustainable Materials)								
M24PH6DSE302	Biophotonics (Biophysics)								
M24PH6DSE303	Semiconductor Optoelectronic Devices (Electronics)	Any one	DSE	4	5	3	0	2	0
M24PH6DSE304	Sustainable energy Sources (Sustainable Materials)								
M24PH6DSE305	Biophysics and Sports Biomechanics (Biophysics)								
M24PH6DSE306	Science of Sound								
M24PH6DSE307	Exploring the Cosmos								
M24PH6SEC300	Basics of AI and Machine Learning		SEC	3	4	2	0	2	0
M24PH6VAC300	Foundations in Forensic Science	Any one	VAC	3	3	3	0	0	0
M24PH6VAC301	Environmental Physics and Human Rights								

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

Semester: 7

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
M24PH7DCC400	Statistical Physics	DCC	4	5	3	0	2	0
M24PH7DCC401	Mathematical Physics	DCC	4	4	4	0	0	0
M24PH7DCC402	Electrodynamics	DCC	4	4	4	0	0	0
M24PH7DCE400	Atomic and Molecular Physics	DCE	4	4	4	0	0	0
M24PH7DCE401	Nanophotonics							
M24PH7DCE402	Energy Conversion and Storage Systems							
M24PH7DCE403	Advanced Classical Mechanics							
M24PH7DCE404	Research and Professional Ethics							
M24PH7DCE405	General Relativity and Applications							

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

Semester: 8

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
M24PH8DCC400	Advanced Quantum Mechanics	DCC	4	5	3	0	2	0
M24PH8DCC401	Condensed Matter Physics	DCC	4	5	3	0	2	0
M24PH8DCE400	Advanced Nuclear and Particle Physics	DCE	4	5	3	0	2	0
M24PH8DCE401	Electronics							
M24PH8DCE402	Microelectonics and Semiconductor Devices							
M24PH8DCE403	Communication Systems							
M24PH8PRJ400	Project* (UG Degree-Honours)		8					
M24PH8PRJ401	Project*(UG Degree - Honours with Research)		12					

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

Semester: 1

Course Code	Title of the Course	Type of the Course	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
M24PH1DSC100	Foundations of Physics	DSC A	4	5	3	0	2	0
M24PH1MDC100	Observational Astronomy	MDC	3	4	2	0	2	0

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

	Mar Athanasius College **Kothamangalam**

Programme	**BSc Physics (Honours)**					
Course Name	**Foundations of Physics**					
Type of Course	MAJOR					
Course Code	M24PH1DSC100					
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 hands on experience in programming using Python.					
Semester	1	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		45		30		75
Pre-requisites if any	Nil					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PSO 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 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	1,2,3
4	To familiarise the concept of programing using Python	U, A, S	2,3,5
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	2,3,5

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**		**11**	
	2.1.1	Force and Interactions, Newton's First Law, Newton's Second Law	1	3
	2.1.2	Mass and Weight, Newton's Third Law, Free-Body Diagrams	2	3
	2.1.3	Newton's Laws- Applications	6	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**		**10**	
	3.1	Introduction to Python, Writing and executing simple Python scripts, Declaring and using variables,	3	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.	4	5
4	**Practical (Error analysis should be done for experiments 1 to 8)**		**30**	5
	4.1	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.		
	4.2	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.		
	4.3	Comparison of microscope and Screw gauge readings by measuring the thickness of a wire.		
	4.4	Parallelogram law of vector addition and determination of unknown mass/density of a liquid using loss of weight concept.		
	4.5	Verification of vector addition using force table.		
	4.6	Laser triangulation- determination of the height of an object using a laser.		
	4.7	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.		
	4.8	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.		
	4.9	Building a basic calculator program using Python.		

5	4.10	Simple Programs using Python.		
	Teacher Specific Content		To be evaluated internally	
	5.1	Assign students to design and demonstrate an experiment to explain conservation of energy		
	5.2	Using Phyton programming calculate and compare the volume and surface area of a thin metallic rod by inputting the data/observation collected in practical 4.1		

Teaching and Learning Approach	Classroom Procedure (Mode of transaction) Lecture, Demonstrations, Animations, Presentations, Discussion, Programming sessions.
Assessment Types	MODE OF ASSESSMENT A**. Continuous Comprehensive Assessment (CCA)** Theory Total = 25 marks Quiz, Test Papers, seminar Practical Total = 15 marks Lab performance, record, field report etc.
	B. End Semester Examination Theory Total = 50 marks, Duration 1.5 hrs Part A (Short answer) – 10 out of 12 x1 =10 marks Part B (Short essay) – 4 out of 6 x 5 = 20 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks Practical Total = 35 marks; Duration- 2 hrs Record 10 marks, Examination 25 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

	Mar Athanasius College **Kothamangalam**

Programme	**BSc Physics (Honours)**					
Course Name	**Observational Astronomy**					
Type of Course	**MDC**					
Course Code	M24PH1MDC100					
Course Level	**100**					
Course Summary	The course is structured to spark curiosity among the students, 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	
		30		30		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
4	To identify the different galaxies, constellations and the salient features	U	1

5	To categorise the diverse objects in the Solar system	U, An	1
6	To gain expertise in handling different tools for observational astronomy	U, S, A, An	1,3,4
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 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

	3.1	Familiarization of telescopes and focusing the objects using a telescope		
	3.2	Illustration of visible spectrum using prism and telescope**.**		
	3.3	Virtual observatory exploration		
	3.4	Making models of astronomical phenomena and objects		
	3.5	Identifying and documenting planets/stars		
	3.6	Find the Orion Constellation. Name three stars in the belt and prepare a report of these stars as pointer stars		
	3.7	Mapping and categorization of constellations		
	3.8	Observe and sketch the map of constellations observable in any one night		
	3.9	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.		
	3.10	Learn to use Astronomy software - Any two activities of identification		
	3.11	Observatory visit		
	3.12	Observe and Identify Sunspots		
5		Teacher specific content 1. Starry Night Picnic- Organize a casual evening picnic where students can gaze at the night sky, and identify constellations using a stargazing app. 2. Astrophotography-Night Sky Photography 3. Telescope making workshop	To be evaluated internally	

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 Total = 15 marks Quiz, Test Papers, seminar Practical Total = 15 marks Lab performance, record, field report etc.
	B. End Semester Examination Theory Total = 35 marks, Duration 1 hrs Part A (Short answer) – 10 out of 12 x1 =10 marks Part B (Short essay) – 3 out of 6 x 5 = 15 marks Part C (Long essay) – 1 out of 2 x 10 = 10 marks Practical Total = 35 marks; Duration- 2 hrs Record 10 marks, Examination 25 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: 2

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
M24PH2DSC100	Modern Physics	DSC A	4	5	3	0	2	0
M24PH2MDC100	Physics in Sports	MDC	3	4	2	0	2	0

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

	Mar Athanasius College Kothamangalam

Programme	**BSc Physics (Honours)**					
Course Name	**Modern Physics**					
Type of Course	MAJOR					
Course Code	M24PH2DSC100					
Course Level	**100**					
Course Summary	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. An overview on medical technologies, diagnostic tools, and treatment methods emerged as a result of modern physics discoveries is also included. Hands on experience on experiments based on phenomenon discovered during 20th century is added in practical					
Semester	2	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		45		30		75
Pre-requisites, if any	NA					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	To acquire in depth knowledge on 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 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 and application of the structure of matter.	U, Ap	1,2
5	To understand and get interest in the application of modern physics technologies in medical instruments	U, I, Ap	1,4
6	To gain hands on expertise in experiments related to modern physics	S, A, An	3,5

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	**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	Nuclear Atom, Electron Orbits, Atomic Spectra, Bohr atom model, 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 Medical Instruments		**10**	
	3.2.1	Introduction to Modern Physics in Medicine: An overview of how principles from modern physics, such as quantum mechanics, electromagnetism, and nuclear physics, are applied in medical technologies.	**1**	5
	3.2.2	Medical Imaging: X-ray imaging, computed tomography (CT) scan, magnetic resonance imaging (MRI), positron emission tomography (PET), and ultrasound imaging.	**3**	5
	3.2.3	Medical Lasers and Optics: Laser surgery, photodynamic therapy, and optical coherence tomography (OCT).	**2**	5
	3.2.4	Radiation Therapy: Ionizing radiation to treat cancer, including techniques like external beam radiation therapy, brachytherapy, and proton therapy.	**2**	5
	3.2.5	Nuclear Medicine: Use of radioactive isotopes for diagnostic imaging and therapy, such as in single-photon emission computed tomography (SPECT) and PET imaging.	**2**	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	Teacher specific content Recent advancements in medical instruments Emerging Technologies: Highlighting recent advancements in medical physics, such as molecular imaging, nanomedicine, and therapeutic ultrasound. This section would discuss cutting-edge research and potential future applications.		To be evaluated internally	

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Demonstrations, Presentations, Discussions
Assessment Types	MODE OF ASSESSMENT A**. Continuous Comprehensive Assessment (CCA)** Theory Total = 25 marks Quiz, Test Papers, seminar Practical Total = 15 marks Lab performance, record, field report etc.
	B. End Semester Examination Theory Total = 50 marks, Duration 1.5 hrs Part A (Short answer) – 10 out of 12 x1 =10 marks Part B (Short essay) – 4 out of 6 x 5 = 20 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks Practical Total = 35 marks; Duration- 2 hrs Record 10 marks, Examination 25 marks

Text Books:

1. Beiser, Arthur, Mahajan. Shobhit, Choudhury, S. Rai. Concepts of modern physics. McGraw Hill Education, 2017 7th Edition
2. Beyer, T. (2021). Medical Physics and Imaging–A Timely Perspective. Frontiers in Physics. https://www.frontiersin.org/articles/10.3389/fphy.2021.634693/full
3. Introduction to Medical Physics-Zanichelli Alessandro Bacchettam & Domenico Scannicchio - CEA (2023)

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.

	Mar Athanasius College **Kothamangalam**

Programme	**BSc Physics (Honours)**					
Course Name	**PHYSICS IN SPORTS**					
Type of Course	**MDC**					
Course Code	**M24PH2MDC100**					
Course Level	**100**					
Course Summary	Focusses on the physical principles behind sports, with the purpose of enabling the student to develop and optimize ideas on sports					
Semester	**2**	**Credits**			**3**	**Total Hours**
Course Details	**Learning Approach**	**Lecture**	**Tutorial**	**Practical**	**Others**	
		30	**0**	**30**	**0**	**60**
Pre-requisite, if any	**Nil**					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PO No
1	Understand the fundamental scientific concepts of body mechanics.	U	1,2
2	Understand basic concepts in physics and interpret relation connecting with sports and know how to use them effectively in tournaments	U	1,2
3	Realize the concept and its application on sports	U, A, An	3
4	Knowledge about basic mechanics applied in sports	A, An,E	4

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	**Mechanics of Human Body**		**15**	
	1.1.1	Definition of Biomechanics & Sports Biomechanics,	3	1
	1.1.2	Importance of Biomechanics for Sports technique	2	1
	1.1.3	Forces in muscles and bones – elastic properties – work, energy and power of the body	2	1
1.2	**Linear and Angular Kinematics**			
	1.2.1	Linear Kinematic Quantities: Distance and Displacement, Speed and velocity, Acceleration, Vectors and scalars, Units	2	2
	1.2.2	Angular Kinematics, Angular Distance and Displacement, Angular Speed and Velocity, Units in angular kinematics, Angular Acceleration	2	2
	1.2.3	Eccentric force, Couple, Moment of force, Moment of Inertia	2	2
	1.2.4	Basic Concepts: Forms of Motion, Linear Motion, Angular Motion, General Motion, Concept of Relative Motion, Newton's Law of Linear Motion	2	2
2	**Physics of Sports**		**15**	
	2.1	Damping, Friction, Rotation, Circular Motion, Gravitation, Projectile, Range of Projectile	2	2
	2.2	Catches, Throws, Thrust, Pressure	2	2,3
	2.3	Basic ideas of flotation – buoyant force – centre of buoyancy – specific gravity - relative motion – fluid resistance – conservation of momentum	2	2,3
	2.4	Air resistance – spin or gyration, Science Behind Various Sports -Basketball, Football, Javelin, Discus, Cricket Batting, Kicking of Football, Badminton, Swimming	3	2

	2.5	Science Behind the Design of Bats - Table Tennis, Cricket, Tennis	2	3,4
	2.6	Cricket Bowling- Magnus Effect, Spin Motion, Reverse Swing	2	2,3,4
	2.7	Throw- Shot Put Throw, Discus Throw and Javelin Throw Athletics - Physics of Running, Long jump, High Jump & Gymnastics	2	2,3,4
3	**Practical**		**30**	
	3.1	Familiarisation and identification of different motions in sports (Ground)		3,4
	3.2	Analysis of Newton's laws of motion in sports		3,4
	3.3	Analysis of physics behind running, long jump, high jump (Ground & Video Analysis)		3,4
	3.4	Analysis of various events: Cricket, Basketball, Football		3,4
	3.5	Analysis of various events: Javelin throw, Discus throw, Badminton, Swimming		3,4
	3.6	Problems related to velocity, acceleration of one dimensional motion in ground		3,4
4		**Teacher specific content**	To be evaluated internally	

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, Observation, Interactive, Group discussion
Assessment Types	**MODE OF ASSESSMENT** A. **Continuous Comprehensive Assessment (CCA)** Theory Total = 15 marks Quiz, Test Papers, seminar Practical Total = 15 marks Lab performance, record, field report etc.

	B. End Semester Examination Theory Total = 35 marks, Duration 1 hrs Part A (Short answer) – 10 out of 12 x1 =10 marks Part B (Short essay) – 3 out of 6 x 5 = 15 marks Part C (Long essay) – 1 out of 2 x 10 = 10 marks Practical Total = 35 marks; Duration- 2 hrs Record 10 marks, Examination 25 marks

Textbooks

1. The Biomechanics of Sports Technique, Third Ed. Hay. G. James .
2. Scientific Principles of Coaching, Second Ed..
3. The Physics of Sports A Textbook by David R..

References

(1) Concepts in Physics by H C Verma
(2) https://science.howstuffworks.com/engineering/architecture/brunelleschis-dome.htm
(3) General Physics with Bioscience Essays, Marion and Noryak, Second Ed,

Semester: 3

Course Code	Title of the Course		Type of the Course	Credit	Hours / week	Hour Distribution /week			
						L	T	P	O
M24PH3DSC200	Mechanics and Properties of Matter		DSC A	4	5	3	0	2	0
M24PH3DSC201	Essential Mathematics for Physics		DSC A	4	4	4	0	0	0
M24PH3DSE200	Semiconductor Physics (Electronics)	Any One	DSE	4	5	3	0	2	0
M24PH3DSE201	Introduction to Optics (Photonics)								
M24PH3DSE202	C++ for Computational Physics (Computational Physics)								
M24PH3DSC202	Basic Electronics and Electricity		DSC B	4	5	3	0	2	0
M24PH3MDC200	Introduction to Medical Physics		MDC	3	3	3	0	0	0
M24PH3VAC200	Science and Society		VAC	3	3	3	0	0	0

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

	Mar Athanasius College Kothamangalam

Programme	**BSc Physics (Honours)**					
Course Name	**Mechanics and Properties of Matter**					
Type of Course	MAJOR					
Course Code	M24PH3DSC200					
Course Level	**200**					
Course Summary	This course covers fundamental principles in classical mechanics including harmonic motion and waves. The course delves into rotational dynamics, covering angular momentum conservation, rigid body rotation, and Kepler's laws. In addition, the student will explore key concepts related to elasticity of materials and fluid dynamics. This course also provides hands-on experience in practical based on mechanics and properties of matter.					
Semester	3	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		45	0	30		75
Pre-requisite, if any	NA					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PSO No
1	To analyse the simple harmonic motion and damped harmonic motion and to distinguish between different types of damping.	A, E	1,2
2	To gain a thorough understanding of wave motion, including the properties of amplitude, wavelength, frequency, and wave speed	U, An	1.2
3	To understand the dynamics of rotation and apply the law of Mechanics	A, An, E	2,3
4	To gain a basic knowledge on elasticity principles including Hooke's Law, elastic moduli and to predict the behaviour of materials under different stress and strain conditions	U, E	2,4
5	To illustrate the dynamics of fluids, with a focus on viscosity, surface tension and capillary rise.	An,E	1,2,3
6	To apply and analyse the laws of mechanics in various experiments.	U, A, An,Ap	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	**Harmonic Motion and Waves**		**16**	
	1.1	Springs and pendulum, solving the differential equations	**3**	1
	1.2	The damped harmonic oscillator, underdamped oscillator, the overdamped oscillator, the critically damped oscillator.	**4**	1
	1.3	Forced harmonic oscillator-obtaining solution	**4**	1
	1.4	Wave Motion, Equation of a plane progressive wave, distinction between progressive and stationary wave, Types of waves, Transverse and Longitudinal waves.	**3**	2
	1.5	Superposition of waves and Beats, Doppler Effect	**2**	2
2	**Rotational Dynamics**		**12**	
	2.1	Definition of angular momentum, conservation of angular momentum, angular momentum of a system of particles, angular momentum relative to the center of mass, rotation of a rigid body about a fixed axis.	**5**	3
	2.2	A linearly accelerating reference frame, a rotating coordinate frame, fictitious forces, centrifugal forces and the Plumb bob, the Coriolis force	**5**	3
	2.3	Kepler's laws	**2**	3
3	**Elasticity, Viscosity and Surface Tension**		**17**	
	3.1	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**	4
	3.2	Twisting couple, torsion pendulum, determination of moment of inertia.	**2**	4

	3.3	Bending of beams, bending moment, Cantilever (when weight is ineffective);	**2**	4
	3.4	Streamline and Turbulent flow, Coefficient of Viscosity-Poiseuille's Method, Equation of Continuity	**2**	5
	3.5	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	**4**	5
	3.6	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**	5
4	**Practical**		**30**	**8**
	1	Length of simple pendulum equivalent to a symmetric compound pendulum.		6
	2	Determination of moment of inertia of a bar		6
	3	Determination of moment of inertia of a flywheel.		6
	4	Length of simple pendulum equivalent to a Kater's pendulum		66
	5	Determination of moment of inertia of a disc using torsion pendulum.		6
	6	Study the motion of a string and calculate i) spring constant and ii) acceleration due to gravity.		6
	7	Length of simple pendulum equivalent to an asymmetric compound pendulum.		6
	8	Determination of rigidity modulus- Static torsion method.		6
	9	Effect of impurities on surface tension- capillary rise method.		6
	10	Determination of Poisson's ratio of rubber.		6
5		Teacher specific content		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Demonstrations, Presentations, discussions
Assessment Types	A**. Continuous Comprehensive Assessment (CCA)** Theory Total = 25 marks Quiz, Test Papers, seminar Practical Total = 15 marks Lab performance, record, field report etc.
	B. End Semester Examination Theory Total = 50 marks, Duration 1.5 hrs Part A (Short answer) – 10 out of 12 x1 =10 marks Part B (Short essay) – 4 out of 6 x 5 = 20 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks Practical Total = 35 marks; Duration- 2 hrs Record 10 marks, Examination 25 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. BrijLal and Subrahmanyam N., Properties of Matter, S.Chand and Co. 2003.
4. Upadhyaya J. C., Mechanics Ram Prasad Publications 2017

	Mar Athanasius College Kothamangalam

Programme	**BSc Physics (Honours)**					
Course Name	**Essential Mathematics for Physics**					
Type of Course	**DSC A**					
Course Code	M24PH3DSC201					
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	
		60		0		60
Pre-requisites if any	Higher Secondary School level knowledge in Mathematics					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PSO No
1	To understand and apply concepts of vector algebra.	U	1
2	To analyze and manipulate matrices with a focus on special types.	A, An	1, 2
3	To understand and evaluate eigenvectors and eigenvalues	U, E	1, 2
4	To apply vector calculus in real-world physical scenarios.	A	3
5	To solve problems involving curvilinear coordinates and coordinate transformations.	A, An	2
6	To evaluate line, surface, and volume integrals, applying the divergence and Stokes' theorems.	An, E	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	**Introductory Vector Analysis**		**15**	
	1.1	Scalars and vectors, Representation of vector, Position vector and displacement vector, Vector Operations	**5**	1
	1.2	Resolution of vector, Examples	**3**	1
	1.3	Scalar product and vector products, Applications	**3**	1
	1.4	Triple products: Scalar triple product, vector triple product- geometrical meaning.	**4**	1
2	**Matrices**		**15**	
	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, 3
	2.2	The inverse of a matrix	**3**	2, 3
	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, 3
	2.4	Eigenvectors and eigenvalues, Hermitian and Anti-Hermitian, unitary matrices.	**3**	2, 3
	2.5	Determination of eigenvalues and eigenvectors, Cayley-Hamilton Theorem.	**3**	2, 3
3	**Curvilinear coordinate**		**15**	
	3.1	Coordinate systems: Cartesian coordinate system	**3**	4
	3.2	Spherical polar coordinates	**4**	4
	3.3	Cylindrical coordinates	**4**	4
	3.4	Orthogonal Curvilinear coordinate system- Cartesian, Cylindrical and Spherical polar	**4**	4

		coordinate system.		
4	**Vector calculus and Tensors**		**15**	
	4.1	Line integrals, Evaluating line integrals, Physical examples of line integrals, Line integrals with respect to a scalar. Examples	**5**	6
	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. Examples	**5**	6
	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. Differential operators in terms of orthogonal curvilinear coordinates: Gradient, divergence, curl and Laplacian in terms of orthogonal curvilinear coordinates, cartesian, spherical polar, cylindrical coordinate system.(expressions only)	**5**	6
5		Teacher specific content	**To be evaluated internally**	

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 Total = 30 marks Quiz, Test Papers, seminar
	B**. End Semester Examination** Theory Total = 70 marks, Duration 2 hrs Part A (Short answer) – 10 out of 12 x 2 = 20 marks Part B (Short essay) – 6 out of 9 x 5 = 30 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks

Textbook

1. David J Griffith, Introduction to Electrodynamics
2. Mathematical Physics, Satya Prakash, S. Chand & Sons.
3. Mathematical Physics, H.K. Dass, S. Chand & Co. New Delhi.
4. Tensor Calculus: Theory and Problems: A N Srivastava, University Press,1992

5. 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. Mathematical Physics, B.D. Gupta, Vikas Pub.House, New Delhi

	Mar Athanasius College **Kothamangalam**

Programme	**BSc Physics (Honours)**					
Course Name	**Semiconductor Physics**					
Type of Course	DSE					
Course Code	M24PH3DSE200					
Course Level	**200**					
Course Summary	The Semiconductor Physics course delves into the working of semiconductor materials, focusing on their electronic properties and applications. It explores the behavior of electrons and holes within semiconductors, as well as the principles underlying semiconductor devices. The course aims to equip students with a deep understanding of semiconductor diodes and transistors and its significance in modern technology. By the end of the course, students will have acquired a comprehensive understanding of semiconductor physics and its applications, positioning them for further study or careers in semiconductor research, device engineering, or related fields.					
Semester	4	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		45		30		75
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Acquire basic concepts of semiconductors and apply the knowledge to the working of semiconductor devices.	K, A	1
2	To impart ideas regarding bipolar junction transistors, transistor configurations and biasing	U	1
3	Recognize the basic principles of feedback and their types and realize their application in the construction of amplifiers and oscillators.	An, S	1, 3

4	Understand the applicability of amplifiers and oscillators to perform basic designs of modulator circuits	U, E	1, 2
5	Study modulation and demodulation in the field of communication.	U	1
6	Acquire collaboration skills through team-based laboratory activities.	U, A, An, I, S	1, 5, 6
7	To design and construct simple,electronic circuits	U, A, An, C	2, 3, 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	**Semiconducting diodes and applications**		**15**	
1	1.1	PN Junction, Depletion layer, Barrier potential, Biasing- forward and reverse, Reverse breakdown, Junction capacitance and diffusion capacitance	3	1
	1.2	PN Junction diode – V-I characteristics–Diode parameters, Diode current Equation (derivation), Diode testing, Ideal diode.	2	1
	1.3	Zener diode and its reverse characteristics, Zener diode voltage regulator, Thermistors.	2	1
	1.4	Rectification - Half wave, Full wave, Centre tapped, Bridge rectifier circuits - Nature of rectified output, Efficiency & Ripple factor	3	1
	1.5	Filter circuits – Inductor Filter, Capacitor Filter, LC Filter, π Filter	2	1
	1.6	Voltage multipliers – Doubler & Tripler- Wave shaping circuits - Clipper-Positive, negative and biased – Clampers- Positive, negative and biased clampers.	3	1
2	**Transistors Configurations and Feedback**		15	
2	2.1	Bipolar junction transistors, Transistor biasing, CB, CC, CE configurations and their characteristics- Active, saturation and cut-off regions. Current gain α, β, γ and their relationships	6	1, 2
	2.2	Leakage currents- Thermal runaway. DC operating point and AC and DC Load line, Q-Point.	3	2
	2.3	Basic principles of feedback, positive & negative feedback, Advantages of negative feedback	3	3

	2.4	negative feedback circuits – voltage series & shunt, current series & shunt. Need for biasing- Stabilization- Voltage divider bias.	3	3
3	**Amplifiers, Oscillators and Modulation**		15	
3	3.1	Single-stage transistor amplifiers - CE amplifier - amplification factors. Decibel system, Variations in Amplifier gain with frequency.	4	4
	3.2	Oscillatory Circuits, LC oscillators – Hartley Oscillator, Colpit's Oscillator, RC oscillators - Phase shift Oscillator. Astable and monostable multivibrator (basic idea only)	5	4
	3.3	Types of modulation – AM, FM, Pulse modulation and Phase modulation (qualitative study only). Amplitude modulation- modulation index - Analysis of AM wave – Sidebands –bandwidth- AM Demodulation.	6	5
4	Teacher specific content		To be evaluated internally	
5	**Lab Content**		30	6, 7
	4.1	To measure (a) Voltage, and (b) Frequency of a periodic waveform using CRO		
	4.2	Zener characteristics – forward and reverse – Study of dynamic and static properties		
	4.3	Half wave rectifier – Study of ripple factor and load regulation with and without, filter circuit		
	4.4	Transistor characteristics – Common Emitter Configuration		
	4.5	Full wave rectifier – (center tap) – Study of ripple factor and load regulation with and without filter circuit		
	4.6	Full wave rectifier – (bridge) – Study of ripple factor and load regulation with and without filter circuit		
	4.7	Voltage regulator using zener diode – Study of line and load regulations		
	4.8	Clippers – positive, negative and biased – Study of output waveforms		
	4.9	Clampers – positive, negative and biased – Study of output waveforms		
	4.10	LC Oscillator – Colpit's /Hartley – using transistor		

	4.11	Phase shift oscillator – using transistor		
	4.12	Astable Multivibrator using Transistor		
	4.13	Monostable Multivibrator using Transistor		
	4.14	RC coupled common emitter amplifier – Study of frequency response and bandwidth		
	4.15	Voltage multipliers – doubler & tripler		
	4.16	Wave shaping R C circuits – Integrator and differentiator		
	4.17	Amplitude modulation using transistor		
	4.18	To study IV characteristics of PN diode, Zener and Light emitting diode		
	4.19	To study the characteristics of a Transistor in CE configuration.		
	4.20	To design a CE amplifier of given gain (mid-gain) using voltage divider bias.		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, Tutorial, Demonstration
Assessment Types	**MODE OF ASSESSMENT** A**. Continuous Comprehensive Assessment (CCA)** Theory Total = 25 marks Quiz, Test Papers, seminar Practical Total = 15 marks Lab performance, record, field report etc.

	B. End Semester Examination Theory Total = 50 marks, Duration 1.5 hrs Part A (Short answer) – 10 out of 12 x1 =10 marks Part B (Short essay) – 4 out of 6 x 5 = 20 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks Practical Total = 35 marks; Duration- 2 hrs Record 10 marks, Examination 25 marks

Text Book:

1. Basic Electronics-B.L.Theraja
2. A Text Book of Applied Electronics-R.S.Sedha

References:

1. Principles of electronics, VK Mehta, S Chand
2. Basic Electronics(7^{th}Edition), Malvino and Bates, TMH
3. Electronics Fundamentals and Applications- D. Chattopadhyay and P.G.Rakshit, New Age International Publishers.
4. Electronics: Fundamentals of Analog circuits, Thomas L. Floyd, David Buchla, Prentice Hall
5. Electronic Devices and Circuit Theory, Robert Boylestad, Louis Nashelsky, Prentice Hall
6. Basic Electronics, Debashis De , Pearson 2010
7. Basic Electronics, Santiram Kal, PHI 2010
8. Filter Analysis, Bhargava & Kulkshetra Chatopadhyay.

Text books for Lab Activities:

1. Electronics lab manual Vol 1 & 2, K A Navas.
2. Electronics lab manual Vol 1 & 2, Kuryachan T D and Shyam Mohan S, Ayodhya pub.

	Mar Athanasius College **Kothamangalam**

Programme	**BSc Physics (Honours)**					
Course Name	**Introduction to Optics**					
Type of Course	**DSE**					
Course Code	**M24PH3DSE202**					
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	3	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		45	0	30	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 ligh, Understand the concepts of speed, frequency and wavelength of light	U	
2	Understand certain optical phenomenon, Apply the basic ideas of geometric optics, Analyse some basic optical systems	U, A, An	
3	Explain the concepts of wavefronts, Apply the basic ideas of wave optics	U, A	

4	To apply the concepts of optical phenomena in experiments.	U, A, S	
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	1, 2
	1.3	Snells' law, relative and absolute refractive indices, total internal reflection and Critical angle,	3	2
	1.4	Geometrical path length & optical path length of rays.	2	2
	1.5	Concept of wavefronts & rays, concept of vergence- divergence, convergence.	3	2,3
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	2
	2.2	Application: Thick and thin lens matrices, Derivation of Lens maker's formula.	3	2
	2.3	**Introduction to Wave Optics:** Wavefront and Huygens principle, reflection and refraction of plane wave at a plane surface using wave fronts	4	3

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

	9	Familiarisation experiments using telescope:(one) ● Determination of focal length of objective . ● Measurement of angular sizes		4
	10	Familiarisation experiments using microscope (one) ● Measurement of diameter/length ● Thickness of any thin sheets (glass, paper etc)		4
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 Total = 25 marks Quiz, Test Papers, seminar Practical Total = 15 marks Lab performance, record, field report etc.
	B. End Semester Examination Theory Total = 50 marks, Duration 1.5 hrs Part A (Short answer) – 10 out of 12 x1 =10 marks Part B (Short essay) – 4 out of 6 x 5 = 20 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks Practical Total = 35 marks; Duration- 2 hrs Record 10 marks, Examination 25 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.

	Mar Athanasius College Kothamangalam

Programme	**BSc Physics (Honours)**					
Course Name	**C++ for Computational Physics**					
Type of Course	DSE					
Course Code	M24PH3DSE202					
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	
		45		30		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
2	To explain the concept of object-oriented programming and basic principles of classes and objects in C++	U	2
3	To discuss the key control flow structures in C++ such as if statements, loops, and functions.	U	3
4	To foster an understanding of the broader implications and impacts of programming skills and algorithm development and to debug the logical errors and syntax problems.	A, An, C	4
5	Attain competency in programming by developing simple to moderately complex C++ programs and by implementing C++ programming basics to physical problems	S, An	5

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, Basic Program Structure, Tokens, Decision Making, Looping.**		**15**	
	1.1	Basic concepts of Object Oriented programming. Steps in developing a program: Algorithm and flowchart	**3**	1
	1.2	Basic C++ program construction. Tokens: keywords, identifiers, constants, strings, operators; Expressions and their types; Control structures	**3**	1
	1.3	Operators (arithmetic operators, unary operators, relational operators, logical operators, assignment operators)	**3**	1, 5
	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, loop control - break, continue and go to statements,	**3**	1, 2
2	**Arrays, Functions**		**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, 5
3	**Classes and Objects, File Handling**		**15**	
	3.1	Specifying a class - Defining member functions - nesting of member functions - private member functions – arrays within a class – Memory allocation for object- static data - static member functions – arrays of objects – friendly functions.	**11**	1, 5
	3.4	Operator overloading- Defining operator overloading- Overloading unary and binary - Pointers – Polymorphism. File handling in C++ : fstream, open, fclose, fread, fwrite, etc.	**4**	1, 5

4	**Practicals (any 6)**		**30**	1, 2, 3, 4, 5
	1	Solving a quadratic equation		
	2	Conversion of a decimal number into a binary number		
	3	Sorting an array of 10 numbers in ascending/ descending order		
	4	Adding of two matrices		
	5	Multiplication of two matrices		
	6	Generate n prime numbers		
	7	Generate Fibonacci series		
	8	Find out the determinant of a given matrix		
	9	Resistance colour code to its numerical value		
	10	Time of flight, Horizontal range and Maximum height attained by a projectile taking initial velocity and angle of projection as inputs.		
	11	Acceleration due to gravity from given experimental data obtained using simple pendulum		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Hands on training, Programming exercises, Debugging exercises, Tutorials, Interactive Discussions
Assessment Types	**MODE OF ASSESSMENT** A**. Continuous Comprehensive Assessment (CCA)** Theory Total = 25 marks Quiz, Test Papers, seminar Practical Total = 15 marks Lab performance, record, field report etc.

	B. End Semester Examination Theory Total = 50 marks, Duration 1.5 hrs Part A (Short answer) – 10 out of 12 x1 =10 marks Part B (Short essay) – 4 out of 6 x 5 = 20 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks Practical Total = 35 marks; Duration- 2 hrs Record 10 marks, Examination 25 marks

Textbook

1. Balagurusamy, E. "Object oriented programming with C++." McGrawhill 4th Edition 2008.
2. Sankara Rao S. Numerical Methods For Scientists And Engineers PHI Learning Pvt. Ltd., 2017.

Reference

1. Lafore, Robert. Object-oriented programming in C++. Sams Publishing, 2002.

	Mar Athanasius College **Kothamangalam**

Programme	**BSc Physics (Honours)**					
Course Name	**Basic Electronics and Electricity**					
Type of Course	DSC B					
Course Code	M24PH3DSC202					
Course Level	**200**					
Course Summary	The Basic Electronics and Electricity course is designed to provide students with fundamental knowledge and skills in the field of electronics and electrical circuits. Throughout the course, students will explore the principles and applications of electricity, electronic components, and basic circuits. The curriculum emphasizes hands-on learning experiences and problem-solving exercises to reinforce theoretical concepts. By the end of the course, students will have a solid foundation in basic electronics and electricity, enabling them to pursue further studies in the field or apply their knowledge in various technical and engineering applications.					
Semester	4	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		45		30		75
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Acquire basic concepts of semiconductors and apply the knowledge to the working of semiconductor devices.	K, A	1
2	To impart ideas regarding bipolar junction transistors, transistor configurations and biasing	U	1, 2, 3
3	Acquire adequate knowledge in number systems and binary logic.	U, A	1
4	Study the voltage-current relation of all alternating current circuits and some of their applications.	U, An	1, 2
5	Solve complex problems involving linear electrical networks with network theorems	E, A	2, 3

6	Acquire collaboration skills through team-based laboratory activities.	U, A, An, I, S	1, 5, 6
7	To design and construct simple electrical and electronic circuits	U, A, An, C, S	2, 3, 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	**Electronics**		**15**	
1	1.1	Semiconductors, Intrinsic semiconductors, doping, extrinsic semiconductors	3	1
	1.2	PN junction diode, forward and reverse bias, energy bands, diode characteristics	4	1
	1.3	Half wave rectifier, full wave centre tap rectifier, ripple factor and efficiency(mathematical derivations not needed)	2	1
	1.4	Zener diode, characteristics, Zener diode as a voltage regulator	2	1
	1.5	Transistor- basic ideas, the biased transistor, CE connection- idea of CE amplifier	4	2
2	**Digital Electronics**		**15**	
2	2.1	Number system, decimal to binary, and binary to decimal conversion	2	3
	2.2	Binary arithmetic- 1's and 2's complement	3	3
	2.3	Hexadecimal numbers- decimal to hexadecimal, hexadecimal to decimal, and binary	2	3
	2.4	Basic Boolean algebra, Demorgan's laws, Simplification of Boolean equations	4	3
	2.5	Logic gates- NOT, OR, AND- symbol, truth table. Universal gates - NAND, NOR, half adder- full adder	4	3
3	**Electricity**		**15**	

3.	3.1	AC Circuits: Kirchhoff's laws for AC circuits.	2	4
	3.2	(Mathematical derivation not needed) Series LCR Circuit: (1) Resonance, (2) Power Dissipation (3) Quality Factor, and (4) Band Width. Parallel LCR Circuit.	3	4
	3.3	Transient Currents: Growth and decay of current in an LR circuit- Charging and discharging of a capacitor through a resistor , Peak, mean, rms and effective values of AC.	4	4
	3.4	AC through RC, LC, LR - Growth and decay of charge in an LCR circuit. (Mathematical derivation not needed) - resonance-sharpness of resonance-power factor.	3	4
	3.5	**Network theorems:** Thevenin theorem, Norton theorem, Superposition theorem, Maximum Power Transfer theorem.	3	5
4	Teacher specific content		To be evaluated internally	

5	**Lab Content**		**30**	6, 7
	4.1	To measure (a) Voltage, and (b) Frequency of a periodic waveform using CRO		
	4.2	Zener characteristics – forward and reverse – Study of dynamic and static properties		
	4.3	Half wave rectifier – Study of ripple factor and load regulation with and without, filter circuit		
	4.4	Transistor characteristics – Common Emitter Configuration		
	4.5	Full wave rectifier – (center tap) – Study of ripple factor and load regulation with and without filter circuit		
	4.6	Full wave rectifier – (bridge) – Study of ripple factor and load regulation with and without filter circuit		
	4.7	Voltage regulator using zener diode – Study of line and load regulations		
	4.8	Clippers – positive, negative and biased – Study of output waveforms		
	4.9	Clampers – positive, negative and biased – Study of output waveforms		

	4.10	To study IV characteristics of PN diode, Zener and Light emitting diode		
	4.11	To study the characteristics of a Transistor in CE configuration.		
	4.12	To design a CE amplifier of given gain (mid-gain) using voltage divider bias.		
	4.13	Realization of logic gates using diodes and transistors		
	4.14	Verification of truth table - basic logic gates		
	4.15	Verification of truth table - universal gates		
	4.16	Construction of basic gates using NAND/NOR gates		
	4.17	Series LCR circuit - Q factor		
	4.18	Verification of Thevenin's and Norton's theorems		
	4.19	Verification of Superposition and Maximum power transfer theorems.		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, Tutorial, Demonstration
Assessment Types	**MODE OF ASSESSMENT** A**. Continuous Comprehensive Assessment (CCA)** Theory Total = 25 marks Quiz, Test Papers, seminar Practical Total = 15 marks Lab performance, record, field report etc

	B. End Semester Examination Theory Total = 50 marks, Duration 1.5 hrs Part A (Short answer) – 10 out of 12 x1 =10 marks Part B (Short essay) – 4 out of 6 x 5 = 20 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks Practical Total = 35 marks; Duration- 2 hrs Record 10 marks, Examination 25 marks

Text Book:

1. Electronic Principle- Albert Malvino, David J Bates- MGH
2. Digital Fundamentals -Thomas L Floyd- Pearson
3. Electricity and Magnetism, R. Murugeshan- Chapters 12, 8 and 32

References

1. Principles of electronics, VK Mehta, S Chand
2. Basic Electronics(7thEdition), Malvino and Bates, TMH
3. Electronics Fundamentals and Applications- D. Chattopadhyay and P.G.Rakshit, New Age International Publishers.

Textbooks for Lab Activities:

1. Electronics lab manual Vol 1 & 2, K A Navas.
2. Electronics lab manual Vol 1 & 2, Kuryachan T D and Shyam Mohan S, Ayodhya pub.

	Mar Athanasius College **Kothamangalam**

Programme	**BSc Physics (Honours)**					
Course Name	**Introduction to Medical Physics**					
Type of Course	**MDC**					
Course Code	M24PH3MDC200					
Course Level	**200**					
Course Summary	This course delves into the physical phenomena encompassing biological systems, highlighting the significant relevance of medical physics. It serves as an introduction to the fundamentals of medical physics for students. Given the evolving lifestyles today, it's essential to comprehend the human body through a physics lens. This course aims to address both these requirements comprehensively.					
Semester	**3**	**Credits**			**3**	**Total Hours**
Course Details	**Learning Approach**	**Lecture**	**Tutorial**	**Practical**	**Others**	
		45	**0**	**0**	**0**	**45**
Pre-requisites, if any	**Nil**					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No
1	Grasping the core principles of physics brings added value to biological systems.	U	1
2	Explain the different imaging systems to identify problems related to biological systems.	U	1,2
3	Identify the experimental techniques for making correct and appropriate use of a range of scientific equipment used in biological systems.	K, U, A	5
4	Examine the biological system through the application of experimental physics techniques.	A, An	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	**Physics of human body**		**15**	
	1.1	Static, dynamic and frictional forces in the body, composition, properties and functions of bones,	4	1
	1.2	Heat and temperature, temperature scales, clinical thermometer, thermography, heat therapy, heat loss from body..	4	1
	1.3	Pressure in the body, skull, eye and urinary bladder	4	1
	1.4	Physics of Respiratory and cardiovascular system.	3	1
2	**Imaging and Therapy**		**15**	
	2.1	Nervous system and neuron, electrical signals from muscle, eye and heart.	4	2
	2.2	Measuring and optical instruments	4	2
	2.3	Introduction to medical imaging, overview of medical imaging techniques (X-rays, CT scans, ECG, MRI) and limitations.	4	2
	2.4	Artificial intelligence and machine learning in medical physics	3	3
3	**Nuclear Medicine and Radiation Therapy**		**15**	
	3.1	Principles of radiation therapy, Radiation detectors and imaging systems,	5	3
	3.2	Radionuclide, Imaging and therapy techniques in nuclear medicine, Radiation exposure and its effects on human health,	5	3,4
	3.3	Regulatory frameworks for radiation safety, Radiation protection practices and equipment	5	3,4
4		**Teacher specific content**		**To be evaluated internally**

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 Total = 25 marks Quiz, Test Papers, seminar
	B. End Semester Examination Theory Total = 50 marks, Duration 1.5 hrs Part A (Short answer) – 10 out of 12 x1 =10 marks Part B (Short essay) – 4 out of 6 x 5 = 20 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks

Textbooks

1. Biology in Physics: Is Life Matter? K.A. Bogdanov and Konstantin Bogdanov, Academic press, 1999.
2. R.S.Khandpur – Handbook of Biomedical Instrumentation, Tata McGraw Hill Publication Co.,Delhi,1987.
3. Medical Imaging: Principles and Practices by David Dowsett and Patrick Kench

References

(1) John R. Cameron and James G. Skofronick, John Wiley &Sons –Medical Physics, Wiley – InterscicencePublications ,1978.
(2) Radiation Oncology: Rationale, Technique, Results by James D. Cox, et al.

	Mar Athanasius College **Kothamangalam**

Programme	**BSc Physics (Honours)**					
Course Name	**Science and Society**					
Type of Course	**VAC**					
Course Code	**M24PH3VAC200**					
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**	
		45	**0**	**0**	**0**	**45**
Pre-requisites, if any	**Nil**					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO 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 and address ethical issues related to the practice of Modern Technology	U	1,2
3	To point out the need of practicing Scientific temper in daily life and evaluate the distinction between myth and fact in Science by using case studies	U, A, An	1,2
4	To evaluate the errors involved in the measurements	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	**1.1 Science and Scientific methods**		**16**	
	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			2
	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)**		**14**	
	2.1	Optics and Photonics	1	2
	2.2	Nanotechnology	1	2
	2.3	Space Science	1	2
	2.4	Antibiotics and Vaccination	1	2

	2.5	Atomic Energy	1	2
	2.6	Semiconductor Revolution and Telecommunication	2	2
	2.7	Artificial Intelligence and Data science	2	2
	2.8	Quantum computing	2	2
	2.9	Ethical issues related to science and technology.	3	2
3	**3.1: Need for Scientific Temper**		**15**	
	3.1.1	Need for an informed public about Science and Technology	2	1,3
	3.1.2	Scientific temper in Indian Constitution & Science Policy in India	2	1,3
	3.2: Myths Versus Facts			
	3.2.1	Astronomy and Astrophysics	1	3
	3.2.2	Eclipse, Origin of Universe	1	3
	3.2.3	Nuclear Radiation -	1	2,3
	3.2.4	Theory of Evolution	2	2,3
	3.3: Addressing Misconceptions in Error Analysis			
	3.3.1	Basic ideas of uncertainty in measurements	2	4
	3.3.2	Random and systematic errors	2	4
	3.3.3	Rejection of Spurious measurements	2	4
4		**Teacher specific content**		**To be evaluated internally**

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, Demonstration, Observation and interactive Session, Group discussion.
Assessment Types	**MODE OF ASSESSMENT** A. **Continuous Comprehensive Assessment (CCA)** Theory Total = 25 marks Quiz, Test Papers, seminar
	B. End Semester Examination Theory Total = 50 marks, Duration 1.5 hrs Part A (Short answer) – 10 out of 12 x1 =10 marks Part B (Short essay) – 4 out of 6 x 5 = 20 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks

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

Course Code	Title of the Course		Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
						L	T	P	O
M24PH4DSC200	Wave Optics		DSC A	4	5	3	0	2	0
M24PH4DSC201	Electromagnetic Theory		DSC A	4	4	4	0	0	0
M24PH4DSE200	Digital Electronics (Electronics)	Any One	DSE	4	5	3	0	2	0
M24PH4DSE201	Laser Physics (Photonics)								
M24PH4DSE202	Numerical Methods for Computational Physics (Computational Physics)								
M24PH4DSC202	Atomic and Molecular Spectroscopy		DSC C	4	5	3	0	2	0
M24PH4SEC200	Electrical Circuits and network skills		SEC	3	3	3	0	0	0
M24PH4VAC200	Green Energy		VAC	3	3	3	0	0	0
M24PH4INT200	Internship		INT	2					

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

	Mar Athanasius College **Kothamangalam**

Programme	**BSc Physics (Honours)**					
Course Name	**Wave Optics**					
Type of Course	DSC A					
Course Code	M24PH4DSC200					
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. Hands-on training on experiments based on the wave nature of light are also included.					
Semester	4	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		45		30		75
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PSO No
1	Describe the concept of waves, characteristics and its mathematical representations	U	1,2
2	Explain the phenomenon of polarisation of light	U	1,2
3	To distinguish different types of polarisation using the concepts of polarisation	U, A, An	3,4
4	Relate superposition principle and interference of light and determine the interference pattern in specific cases.	U, A, An	3,4,5
6	Compare the Fresnel and Fraunhofer Diffraction using wave theory	U, A	5,6
8	Apply the concepts of optical phenomena in experiments.	U, A, S	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	**Polarization of electromagnetic Waves**		**15**	
	1.1	One dimensional waves, Harmonic Waves, Phase and Phase Velocity, Plane Waves, The 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 plate, 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
	2.3	Amplitude-Splitting Interferometers- Inference by a plane parallel thin film, Newtons Rings, Michelson Interferometer	8 5	
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 refractive index of liquid filled in a hollow prism using spectrometer.		8
	3	Determination of refractive index of material of a small angled prism using 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 single slit and calculate slit width		8
	10	To measure the wavelength of laser light using a millimeter scale as grating		8
5		Teacher Specific Content	To be evaluated internally	

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture,Tutorial,Practical, Demonstration.
Assessment Types	**MODE OF ASSESSMENT** A**. Continuous Comprehensive Assessment (CCA)** Theory Total = 25 marks Quiz, Test Papers, seminar Practical Total = 15 marks Lab performance, record, field report etc.
	B. End Semester Examination Theory Total = 50 marks, Duration 1.5 hrs Part A (Short answer) – 10 out of 12 x1 =10 marks Part B (Short essay) – 4 out of 6 x 5 = 20 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks Practical Total = 35 marks; Duration- 2 hrs Record 10 marks, Examination 25 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.

	Mar Athanasius College **Kothamangalam**

Programme	**BSc Physics (Honours)**					
Course Name	**ELECTROMAGNETIC THEORY**					
Type of Course	DSC A					
Course Code	M24PH4DSC201					
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 analyse and solve problems in classical electromagnetism.					
Semester	4	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		60	**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	Understand and determine electric field and potential in electrostatics	U, E	1,2
2	Summarise the concepts of Lorentz force, Magnetic field and Vector potential	U	1,2
3	Make use of Ampere's law in simple cases of Magnetostatics.	U, A	1,2
4	Illustrate the concepts of electric field and magnetic field in matter.	U, A, E	1,2
5	Explain electromotive force, Faraday's law, 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
	1.3	Electric potential, Poisson's Equation and Laplace's Equation, Potential of a localized charge distribution, Boundary Conditions.	3	1
	1.4	Work and energy in electrostatics- Energy of a discrete charge distribution, Energy of a continuous charge distribution.	3	1
	1.5	Conductors: basic properties, induced charges, surface charge.	3	1
2	**Magnetostatics**		**13**	
	2.1	Lorentz force law, Magnetic fields, Magnetic Forces, Currents.	4	2
	2.2	Biot -Savart law, Magnetic Field of Steady Current – Divergence of B, Straight line currents. Amperes Law.	4	2
	2.3	Applications of Ampere's law – Long straight current , Solenoid. Comparison of Magnetostatics and Electrostatics. Magnetic Vector Potential. Magnetostatic Boundary Conditions.	5	2.3
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	4
	3.1.2	Electric displacement, Gauss's law in the presence of dielectrics, Boundary Conditions for D – Linear Dielectrics, Susceptibility, Permittivity, Dielectric constant.	5	4
	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**	4

	3.2.2	Linear and Nonlinear Media, Magnetic susceptibility and permeability.	**3**	4
4	**Maxwell's equations**		**14**	
	4.1	Ohm's law, electromotive force, motional emf – Electromagnetic induction – Faraday's law, induced electric field	**5**	5
	4.2	Electrodynamics before Maxwell, Maxwell's modification of Ampere's law, Maxwell's equations	**5**	5
	4.3	Continuity equation. Wave equation for E and B in vacuum. Maxwells equation in matter.	**4**	5
5	**Teacher specific content**		**To be evaluated internally**	

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Demonstrations, Presentations, discussions
Assessment Types	**MODE OF ASSESSMENT** A**. Continuous Comprehensive Assessment (CCA)** Theory Total = 25 marks Quiz, Test Papers, seminar Practical Total = 15 marks Lab performance, record, field report etc.
	B. End Semester Examination Theory Total = 50 marks, Duration 1.5 hrs Part A (Short answer) – 10 out of 12 x1 =10 marks Part B (Short essay) – 4 out of 6 x 5 = 20 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks Practical Total = 35 marks; Duration- 2 hrs Record 10 marks, Examination 25 marks

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

	Mar Athanasius College **Kothamangalam**

Programme	**Physics**					
Course Name	**Digital Electronics**					
Type of Course	**DSE**					
Course Code	M24PH4DSE200					
Course Level	**200**					
Course Summary	This course in digital electronics introduces students to the fundamental concepts of binary systems, logic gates, Boolean algebra, and combinational and sequential logic circuits. Students will learn to design, analyze, and implement digital circuits using both theoretical knowledge and practical laboratory sessions, gaining essential skills for problem-solving, critical thinking, and logical reasoning in the field of digital electronics.					
Semester	4	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		45		30		75
Pre-requisites if any	Knowledge of Basic Mathematics and Algebra. Basic knowledge of electrical circuits and components would be beneficial.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains*	PSO No
1	Develop critical thinking and analytical reasoning skills through binary system analysis and Boolean algebra operations.	An	1, 2
2	Apply scientific reasoning and problem-solving skills to design and implement combinational and sequential logic circuits.	A	2
3	Demonstrate a multidisciplinary approach by integrating concepts from mathematics, computer science, and engineering to design and optimize digital circuits.	U	3
4	Enhance communication skills through the effective presentation and documentation of digital circuit designs.	A, S	4
5	Foster leadership, entrepreneurship and collaboration skills by promoting innovation and practical problem-solving in digital circuit design.	A, S	5

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 of Digital Electronics**		**15**	
1	1.1	**Binary Systems and Operations** Binary Numbers, Decimal-to-Binary Conversion, Binary Arithmetic, Complements of Binary Numbers, Signed Numbers, Arithmetic Operations with Signed Numbers	5	1, 2
	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	5	1, 2
	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	5	1, 2
2	**Combinational Logic**		15	
2	2.1	**Combinational Logic Analysis** Basic Combinational Logic Circuits, The Universal Property of NAND and NOR gates, Combinational Logic Using NAND and NOR Gates	5	1, 2, 3
	2.2	**Functions of Combinational Logic** Half and Full Adders, Parallel Binary Adders, Decoders, Encoders, Multiplexers, Demultiplexers	5	3, 5
	2.3	**The Karnaugh Map** Introduction, Karnaugh Map SOP Minimization	5	1, 4
3	**Sequential logic**		15	
3	3.1	**Latches and Flip-Flops** Latches, Flip-Flops, Flip-Flop Operating Characteristics, Flip-Flop Applications	5	1, 2, 3, 5
	3.2	**Shift Registers** Shift Register Operations, Types of Shift Register Data I/Os.	5	1, 2, 3, 5
	3.3	**Counters** Asynchronous Counters, Synchronous Counters, Up/Down Synchronous Counters	5	1, 2, 3, 5
4		**Lab Content (Any 6)**	30	1, 2, 3, 4, 5

	4.1	Count sequence of binary numbers		
	4.2	Realization of basic logic gates – AND, OR and NOT – using universal gates and and verification of truth tables		
	4.3	Verification of truth table of NAND, NOR, XOR and XNOR gates		
	4.4	Verification of De Morgan's theorems – Using IC 7400		
	4.5	Verification of Boolean functions simplified using Karnaugh map method		
	4.6	Realization of Half adder/ Full adder using gates – Verification of truth table		
	4.7	Decoder/ Encoder/ Multiplexer/ Demultiplexer using gates		
	4.8	SR Latch using IC 7400 – Verification of truth table		
	4.9	JK Flip Flops using IC 7400 & 7410 – Verification of truth table		
	4.10	Construct and test - Shift register – SISO/ Shift register – SIPO		
	4.11	Construct and test - Asynchronous Counter / Synchronous Counter		
5	Teacher Specific Content		To be evaluated internally	

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, Tutorial, Demonstration, Problem-solving sessions, Interactive discussions, Hands-on sessions, Group activities.
Assessment Types	**MODE OF ASSESSMENT** A**. Continuous Comprehensive Assessment (CCA)** Theory Total = 25 marks Quiz, Test Papers, seminar Practical Total = 15 marks Lab performance, record, field report etc.

	B. End Semester Examination Theory Total = 50 marks, Duration 1.5 hrs Part A (Short answer) – 10 out of 12 x1 =10 marks Part B (Short essay) – 4 out of 6 x 5 = 20 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks Practical Total = 35 marks; Duration- 2 hrs Record 10 marks, Examination 25 marks

Textbooks

1. Floyed Thomas L., *Digital fundamentals*, Pearson Education, 11th edition 2017.
2. Mano, M. Morris, *Digital Logic and Computer Design* 2016.

References

1. William, H. Gothmann. *Digital Electronics*. (1982).
2. Leach D. P., Malvino A. P., and Saha G., *Digital principles and applications*, McGraw Hill, 8th Edition 2014
3. S Salivahanan & S Arivazhagan, *Digital Electronics* VPH (2010)

	Mar Athanasius College **Kothamangalam**

Programme	**BSc Physics (Honours)**					
Course Name	**Laser Physics**					
Type of Course	**DSE**					
Course Code	M24PH4DSE201					
Course Level	**200**					
Course Summary	This course covers the fundamental principles of laser physics, including the basic principles of laser operation, types of lasers, laser amplification, resonators, and laser beam characteristics. Additionally, it provides an understanding of the techniques used for controlling laser output.					
Semester	4	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		45		30		75
Pre-requisites if any	Background in physics at the higher secondary level					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains*	PO No
1	Understand the fundamental principles of laser physics and apply critical thinking to analyze and solve complex problems related to laser operation and characteristics.	U, A, An, S	1, 2, 3
2	Demonstrate scientific reasoning by explaining the operation of various types of lasers and applying appropriate techniques for controlling laser output.	U, A, S	1, 2, 3, 5, 6
3	Apply a multidisciplinary approach by integrating concepts from physics, optics, and quantum mechanics to understand the principles underlying laser operation and characteristics.	U, A, S	1, 4
4	Effectively communicate complex concepts related to laser physics both orally and in writing, demonstrating clear and concise communication skills.	U, S	4, 5
5	Develop leadership, entrepreneurship and collaboration skills by applying knowledge of laser physics to	A, C, S	4, 5, 6

	innovate new technologies and solutions in various fields such as medicine, defense, and communication.		

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 and Basic Principles**		**15**	
1	1.1	A brief history of the laser, Interaction of light and matter, Energy levels, population, thermal equilibrium. Absorption and emission of light, Einstein's prediction and the three processes, Difference between spontaneous and stimulated emission, Einstein's relations, conditions for large stimulated emissions	6	1, 2, 3, 4
	1.2	**Population Inversion and Pumping** Spontaneous and stimulated emissions in the optical region, Conditions for light amplification, lineshape function, Population inversion, pumping, pumping methods, Active medium, metastable states, pumping schemes	4	1, 2, 3. 4
	1.3	**Laser Amplification and Resonators** Amplification and gain, amplifier, optical resonator, action of optical resonator, threshold condition, critical population inversion, condition for the steady state oscillation, cavity resonance frequencies, line broadening, gain saturation, gain bandwidth	5	1, 2, 3, 4
2	**Laser Principles (contd.), Types of Lasers**		15	
2	2.1	Laser operating frequencies, cavity configurations, modes, longitudinal waves, transverse modes, single mode operation.	5	1, 2, 3, 4
	2.2	Laser rate equations, two level systems, three level laser, four level laser, optimum output power, properties of laser modes.	5	1, 2, 3, 4
	2.3	**Types of Lasers** Classification of lasers, Solid state lasers, Gas lasers, Tunable dye lasers, Comparison between solid, liquid and gas lasers, semiconductor laser, free electron laser.	5	1, 2, 3, 4
3	**Laser beam characteristics, Techniques for control of laser output**		15	

3	3.1	**Laser beam characteristics, Laser Applications** Directionality, Intensity, Coherence, Monochromaticity, Polarization, Speckles; Laser Applications	5	1, 2, 3, 4
	3.2	**Techniques for control of laser output** Selecting a narrow frequency range, Selection of TEM00 mode and single longitudinal mode, generation of high power pulses, Q factor, Q switching for giant pulses, Methods of Q switching, Cavity dumping, Mode Locking, Techniques for mode locking.	10	1, 2, 3, 4
4		**Lab Content (Any 6)**	30	1, 2, 3, 4, 5
	4.1	Verification of Snell's law using a laser and a glass slab.		
	4.2	Design and construct a laser beam expander and study its performance.		
	4.3	Study the refraction of a laser beam in a glass slab and measure its refractive index using total internal reflection.		
	4.4	Determination of wavelength of a laser using diffraction grating.		
	4.5	Determine the diameter of a thin wire using laser.		
	4.6	Fraunhoffer diffraction: Wavelength of a laser using a double slit.		
	4.7	Laser diffraction- width of single slit		
	4.8	Determine the refractive index of glass by measuring the Brewster angle using a laser beam.		
	4.9	Measure the divergence of an edge emitting diode laser beam by measuring the dimensions of the beam projected onto a screen at different distances.		
	4.10	To measure the diameter (beam spot size) of the laser beam		
5	Teacher Specific Content		To be evaluated internally	

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, Tutorial, Demonstration, Problem-solving sessions, Interactive discussions, Hands-on sessions, Group activities.

Assessment Types	**MODE OF ASSESSMENT** A**. Continuous Comprehensive Assessment (CCA)** Theory Total = 25 marks Quiz, Test Papers, seminar Practical Total = 15 marks Lab performance, record, field report etc.
	B. End Semester Examination Theory Total = 50 marks, Duration 1.5 hrs Part A (Short answer) – 10 out of 12 x1 =10 marks Part B (Short essay) – 4 out of 6 x 5 = 20 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks Practical Total = 35 marks; Duration- 2 hrs Record 10 marks, Examination 25 marks

Textbooks

1. M N Avadhanulu and P S Hemne, *An Introduction to Lasers: Theory and Applications*, S. Chand, 2013

References

1. Orazio Svelto, *Principles of Lasers*, Springer, Fifth Edition, 2010.
2. K Thyagarajan and Ajoy Ghatak, *Lasers: Fundamentals and Applications*, Macmillan, 2nd Edition, 2011
3. B B Laud, Lasers and Non-linear Optics, New Age International, Third Edition, 2011

	Mar Athanasius College **Kothamangalam**

Programme	**BSc Physics (Honours)**					
Course Name	**Numerical Methods for Computational Physics**					
Type of Course	DSE					
Course Code	M24PH4DSE202					
Course Level	**200**					
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	
		45		30		60
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 numerical methods in computational physics.	U	1, 2
2	To develop the ability to create and implement algorithms for solving physics problems	A, S, C	1, 2, 5

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	**Solution of Algebraic and Transcendental Equations, Solution of Linear System of Equations, Matrix Inversion, Eigenvalue Problems**		15	

	1.1	**Solution of Algebraic and Transcendental Equations:** Bisection Method - Newton Raphson method.	5	1
	1.2	**Solution of Linear System of Equations:** Gauss elimination method - Gauss-Jordan Elimination method - Gauss-Seidel Iteration method **Matrix Inversion:** Gaussian Elimination Method, Gauss - Jordan Method	5	1
	1.3	**Eigenvalue Problems:** Power method and Jacobi's method	5	1
2	**Curve Fitting and Interpolation**		16	
	2.1	**Curve Fitting:** Least squares method - fitting a straight line.	5	1, 2
	2.2	Finite difference operators - Newton's forward difference and backward difference interpolation formulae.	4	1, 2
	2.3	Divided Differences - Newton's divided difference interpolation Formula	4	1, 2
	2.4	Interpolation in two dimensions	3	1, 2
3	**Numerical Differentiation and Integration.**		16	
	3.1	Numerical Differentiation: Differentiation using Difference operators, Differentiation using Interpolation.	8	1, 2
	3.2	Numerical Integration: Newton-Cotes Integration formulae [Concept only] – Trapezoidal rule, Simpson's rules.	8	1, 2
4	**Practicals - C++ Programming (any 6)**		**30**	1, 2, 3, 4, 5
	1	Find the root of the given non-linear equations by the bisection method		
	2	Find the root of the given non-linear equations by the Newton-Raphson method		
	3	Using Newton's formula, compute the pressure for the temperature asked where a table of pressure of a steam at a given temperature is provided.		

	4	Value of some trigonometric function for different theta values are given to you. Using appropriate interpolation technique, calculate the value of the function for a given theta value.		
	5	Numerical integration by the trapezoidal rule - Using the trapezoidal rule, calculate the inner surface area of a parabolic reflecting mirror. (length of semi major axis , semi minor axis and height are to be given)		
	6	Example of Numerical integration by the Simpson rule (both 1/3 and 3/8 rule).		
	7	Fit a straight line using the method of least squares to a set of given data without using any built-in function of curve fitting. Compare your result with any built in curve fitting technique.		
	8	Write a program to solve the given system of linear equations by theGauss elimination method.		
	9	Numerical solution of ordinary first-order differential equations using the Euler methods or the fourth order Runge-Kutta method.		
	10	Find out the inverse of a given matrix by using the Gauss-Jordan method.		
5	Teacher Specific Content		To be evaluated internally	

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, Tutorial, Demonstration, Seminars/ Presentations
Assessment Types	**MODE OF ASSESSMENT** A**. Continuous Comprehensive Assessment (CCA)** Theory Total = 25 marks Quiz, Test Papers, seminar Practical Total = 15 marks Lab performance, record, field report etc.

	B. End Semester Examination Theory Total = 50 marks, Duration 1.5 hrs Part A (Short answer) – 10 out of 12 x1 =10 marks Part B (Short essay) – 4 out of 6 x 5 = 20 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks Practical Total = 35 marks; Duration- 2 hrs Record 10 marks, Examination 25 marks

Text Books

1. Sankara Rao S. *Numerical Methods For Scientists and Engineers* PHI Learning Pvt. Ltd., 2017.

References

1. Sastry, S. S.. *Introductory Methods of Numerical Analysis*. India, PHI Learning, 2012.
2. Verma, R. C.. *Computational Physics: An Introduction*. India, New Age International, 2007.
3. Pang, Tao. *An Introduction to Computational Physics*. Spain, Cambridge University Press, 2006.
4. Sauer Timothy *Numerical Analysis*, 3rd edition, Pearson, 2017.

	Mar Athanasius College **Kothamangalam**

Programme	**BSc Physics (Honours)**					
Course Name	**Atomic and Molecular Spectroscopy**					
Type of Course	DSC C					
Course Code	M24PH4DSC202					
Course Level	**200**					
Course Summary	The course is envisaged to lay the foundation of atomic and molecular spectroscopy and understand how the spectrum arises as radiation interacts with matter. It introduces various spectroscopic techniques and encourages to explore applications.					
Semester	4	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		45		30		75
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Demonstrate a deep understanding of the fundamental principles of quantum mechanics, including wave-particle duality, quantization, superposition, and uncertainty principles.	U	1
2	To understand the historical development from the Bohr atom model to the quantum mechanical model.	K, U	1
3	To make use of the concept of quantum numbers in describing the electron states in atoms	U, A	2
4	Acquire the knowledge on different atom models and will be able to differentiate different atomic systems, different coupling schemes and their interactions with magnetic and	U, A, An	3

	electric fields		
5	Gain an ability of basic problems analysing and solving in physics of atoms and molecules	A, An	3
6	Acquire collaboration skills through team-based laboratory activities.	U, A, An, I, S	1, 5, 6
7	Attain deeper understanding on the subject by performing experiments	U, A, An, C. S	2, 3, 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	**Elementary Quantum Mechanics**		**15**	
	1.1	Introduction- black body radiation and Planck's quantum hypothesis	3	1
	1.2	Photoelectric effect- Einstein's explanation- de Broglie hypothesis- matter wave- Davisson-Germer experiment- uncertainty principle	4	1
	1.3	Wave function- conditions- normalization	3	1
	1.4	Schroedinger equationstationary states- non-normalizable wavefunctions- box normalization	5	1
2	**Atomic Spectroscopy**		**15**	
2	2.1	Rutherford model of atom, Bohr atom model – energy levels and Hydrogen spectra, Absorption and emission spectra, Limitations of Bohr Model	5	2

	2.2	Quantum states of an electron in an atom, Electron Spin, Quantum numbers, Exclusion principle, Orbital and Spin Angular momentum, Space quantisation, Vector atom model	5	2, 3
	2.3	Magnetic moments, Stern- Gerlach experiment, Spectral terms and selection rules, LS and j-j coupling, Fine structure of Sodium D lines	5	3, 4
3	**Molecular Spectroscopy**		**15**	
3	3.1	Regions of Electromagnetic Spectrum, Microwave spectroscopy Rigid diatomic molecules, rotational energy levels	3	5
	3.2	Infrared spectroscopy- Vibrational energy of diatomic molecules, Types of molecules Harmonic oscillator, vibrational energy levels	5	5
	3.3	Raman Scattering- Classical and Quantum theory of Raman Effect, Stokes and anti- stokes lines. Mutual exclusion of IR and Raman spectra	4	5
	3.4	Electronic transitions- UV and Visible spectra Fluorescence and Phosphorescence	3	5
4		**Lab Content**	30	6, 7
	4.1	Verification of Beer-Lambert law- dependence of concentration/path length		
	4.2	Dispersive power of prism using Spectrometer.		
	4.3	Dispersive power of grating using Spectrometer.		

	4.4	Using simulation software (Gamess/Gaussview & Gaussian), visualise the optimized structure of H_2O & CO_2 molecule. Visualise the normal modes of vibrations. Identify the type of vibrations (symmetric stretching, asymmetric stretching, bending etc).		
	4.5	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		
	4.6	Using a (Quantum chemical) computational software compare the IR and Raman spectra of H_2O and CO_2 molecules		
	4.7	Determination of Plank's constant using LED.		
	4.8	Study the V-I characteristics of LEDs emitting different wavelengths and compare their turn-on voltages		
	4.9	Determination of wavelength of a laser using diffraction grating		
	4.10	Spectrometer – Resolving power of a prism.		
	4.11	Spectrometer – Resolving power of grating.		
5	Teacher specific content		To be evaluated internally	

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, Tutorial, Demonstration, Problem-solving sessions, Interactive discussions, Hands-on sessions, Group activities.

Assessment Types	**MODE OF ASSESSMENT** A**. Continuous Comprehensive Assessment (CCA)** Theory Total = 25 marks Quiz, Test Papers, seminar Practical Total = 15 marks Lab performance, record, field report etc.
	B. End Semester Examination Theory Total = 50 marks, Duration 1.5 hrs Part A (Short answer) – 10 out of 12 x1 =10 marks Part B (Short essay) – 4 out of 6 x 5 = 20 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks Practical Total = 35 marks; Duration- 2 hrs Record 10 marks, Examination 25 marks

Text Books

1. Molecular structure and spectroscopy, Aruldas 2nd ed. EEE.
2. Modern Physics, Kenneth S Krane (2nd Edition) -Wiley.
3. Concepts of modern Physics, Arthur Beiser (6th Edition) - SIE.

References:

1. Spectroscopy: Straughan and Walker –(Vol.1) John Wiley
2. Fundamentals of Molecular Spectroscopy: CN Banwell –(4th edition) TMH .
3. Introduction to Atomic Spectra, HE White, TMH
4. Elements of spectroscopy, Guptha, Kumar and Sharma (Pragathi Prakash)

References for Lab Activities:

1. Advanced course in Practical Physics by D Chattopadhyay
2. Practical Physics – Joseph Ittiavirah, Premnath and Abraham(2005)
3. Practical Physics, CL Arora, S.Chand
4. Practical Physics, Harnam Singh , S Chand

	Mar Athanasius College Kothamangalam

Programme	**BSc Physics (Honours)**					
Course Name	**ELECTRICAL CIRCUITS AND NETWORK SKILLS**					
Type of Course	SEC					
Course Code	M24PH4SEC200					
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	
		45	**0**	**0**	**0**	**45**
Pre-requisites, if any	Nil					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains*	PSO No
1	To gain in depth knowledge of various circuit parameters including current, voltage, resistance	U, A	1
2	To familiarise with the basic devices used in the measurement of the circuit parameters	U, A	1
3	To solve the simple AC and DC sourced electrical circuits	A, An	2
4	To demonstrate the basic models of Transformers and generators	U, A, An	1,2
5	To analyse the response of inductors and capacitors with DC or AC sources	U, A, An	3,4
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	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		**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 & DC motors. Basic design. Interfacing DC or AC	2	4
	2.3	Sources to control heaters and motors. Speed & 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	Relays. Fuses and disconnect switches. Automatic main failure switches Circuit breakers. Overload devices. Relay protection device. IoT based smart Switches	2	6
	3.2	Ground-fault protection. Grounding and isolating. Phase reversal. Surge protection and safety measures.	1	6
	3.3	Electrical Wiring: Basics of wiring-Star and delta connection	3	6
	3.4	Voltage drop and losses across cables and conductors. Insulation.	1	6
	3.5	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	
	1	Familiarise with Galvanometer, multimeter, Ammeter voltmeter and wattmeter .		6
	2	Hands on experience on electrical wiring-Basics		6
	3	Demonstration of the use of fuses and familiarisation of gauge of fuse wires		6
	4	Preparation of an extension board		6
	5	Demonstration of MCB's and ELCB's		6
	6	Calculation of Power consumption in various Electrical equipment.		6
	7	Electrical connections for home appliances		6
5		Teacher specific content	To be evaluated internally	

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, Tutorial, Activities, Demonstration
Assessment Types	**MODE OF ASSESSMENT** A. **Continuous Comprehensive Assessment (CCA)** Theory Total = 25 marks Quiz, Test Papers, seminar
	B. End Semester Examination Theory Total = 50 marks, Duration 1.5 hrs Part A (Short answer) – 10 out of 12 x1 =10 marks Part B (Short essay) – 4 out of 6 x 5 = 20 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks

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.

	Mar Athanasius College Kothamangalam

Programme	**BSc Physics (Honours)**					
Course Name	**Green Energy**					
Type of Course	**VAC**					
Course Code	M24PH4VAC200					
Course Level	**200**					
Course Summary	The course provides a comprehensive understanding of work, energy, and power fundamentals. It includes various forms of energy such as renewable and conventional systems like coal, oil and natural gas. It explores the impact of non-conventional energy sources on global warming and examines approaches to energy conservation and governmental policies. Moreover, this course also covers specific renewable energy sources like solar, wind, hydro, tidal, and wave energy. The course touches upon other energy sources, storage methods and provides a broad overview of energy systems and technologies.					
Semester	**3**	Credits			**3**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		45	**0**	**0**	**0**	**45**
Pre-requisite, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PSO No
1	Understand the Energy Systems	U	1,2
2	Understand Solar Energy Technologies and Applications	U	1,2,4
3	Understand Wind Energy Conversion Systems and Policies	An	1,2,4
4	Understand the fundamental principles of hydro resources	U, An	1,2,4
5	Understand the fundamental principles behind piezoelectric and electromagnetic energy harvesting as well as energy storages	E	1,2,4

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		**Introduction**	**15**	
	1.1	Fundamentals of Work, Energy and Power	3	1
	1.2	Various Forms of Energy - Renewable and Conventional energy Systems - Comparison - Coal, Oil and Natural Gas – Availability - Applications – Merits and demerits	4	1
	1.3	Impact Due to Non-Conventional Energy Sources – Global Warming	4	1
	1.4	Approaches to Energy Conservation - Energy Conservation Policies of Different Governmental Bodies	4	1
2		**Solar and Wind Energy**	**15**	
	2.1	Solar Radiation Measurements (qualitative only), Solar Energy Collector, Principles of the Conversion of Solar Radiation into Heat	3	2
	2.2	Classification of Different Types of Solar Energy Collectors (qualitative ideas only) - Merits and Demerits	3	2
	2.3	Solar Energy Storage, Solar Heaters, Solar Cookers, Solar Green Houses	3	2
	2.4	Merits and Demerits of Solar Energy, Solar Cell Technology (basic principle only)	2	2
	2.5	Basic Principles of Wind Energy Conversion, Merits and Demerits	2	3
	2.6	Basic Components of Wind Energy Conversion System; Policies Related to Wind Energy in India, Applications of Wind Energy.	2	3
3		**Other Sources of Energy and Storage**	**15**	
	3.1	Hydro-Resources, Hydro-Project- Types and Hydro-Conversion Technologies; Tidal Resource, Tidal Power Conversion	3	4
	3.2	Wave Resource, Wave Energy Conversion; Challenges to Sustainability	3	4
	3.3	Piezoelectric Energy Harvesting – Physics and Characteristics of Piezoelectric Effect, Piezoelectric Energy Applications	3	**5**

	3.4	Electromagnetic Energy Harvestin; Chemical Energy Resources; Energy Storages - Primary and Secondary Cells –Fuel Cells (basics)	3	5
	3.5	Piezoelectric Energy Harvesting – Physics and Characteristics of Piezoelectric Effect, Piezoelectric Energy Applications	3	5
4		Teacher Specific content	To be evaluated internally	

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 Total = 25 marks Quiz, Test Papers, seminar
	B. End Semester Examination Theory Total = 50 marks, Duration 1.5 hrs Part A (Short answer) – 10 out of 12 x1 =10 marks Part B (Short essay) – 4 out of 6 x 5 = 20 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks

Textbooks

1. Energy Technology: S. Rao and Dr. B.B. Parulekar, Third edition, 2009.
2. Alternative Energy Resources, Green Energy and Technology, Efstathios E. (Stathis) Michaelides, Springer, 2012, DOI 10.1007/978-3-642-20951-2.
3. Non-Conventional Energy Sources, Sri. Shali Habibulla, State Institute of Vocational Education Directorate of Intermediate Education Govt. of Andhra Pradesh, Hyderabad, 2005.
4. Non-Conventional Energy Resources: G. D. Rai, Khanna Publishers, 2008.
5. Solar Energy Fundamentals and application: H.P. Garg and J. Prakash, Tata McGraw - Hill Publishing company Ltd., 1997.

References

1. Power Plant Technology: A. K. Wahil. 1993.
2. Solar energy: S. P. Sukhatme, Tata McGraw- Hill Publishing company Ltd.,1997.
3. Renewable Energy, Power for a sustainable future, Godfrey Boyle, 2004, Oxford University Press, in association with The Open University.
4. Solar Energy: Resource Assessment Handbook, Dr. P Jayakumar, 2009.
5. Wave and Tidal Energy Editor(s): Deborah Greaves, Gregorio Iglesias, First published:23 March 2018, DOI:10.1002/9781119014492, 2018 John Wiley & Sons Ltd.

6. Renewable Energy Resources: John Twidell and Tony Weir, Routledge Publishers ISBN: 978-1138782841.
7. Solar energy: G.D. Rai, Fifth edition, 1995.
8. Renewable Energy: Sources and Methods, Anne Elizabeth Maczulak, 2010.

Semester: 5

Course Code	Title of the Course		Type of the Course	Credit	Hours/ week	Hour Distribution /week			
						L	T	P	O
M24PH5DSC300	Classical and Quantum Mechanics		DSC A	4	4	4	0	0	0
M24PH5DSC301	Elements of Spectroscopy		DSC A	4	4	4	0	0	0
M24PH5DSC302	Nuclear and Particle Physics		DSC A	4	4	4	0	0	0
M24PH5DSE300	Amplifiers and Oscillators (Electronics)	Any two	DSE	4	5	3	0	2	0
M24PH5DSE301	Optoelectronics (Photonics)								
M24PH5DSE302	Computational Physics using Python (Computational Physics)								
M24PH5DSE303	Materials Characterization Techniques (Sustainable Materials)								
M24PH5DSE304	Medical Physics (Biophysics)								
M24PH5SEC300	Research Methodology		SEC	3	3	3	0	0	0

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

	Mar Athanasius College **Kothamangalam**

Programme	**BSc Physics (Honours)**					
Course Name	**Classical and Quantum Mechanics**					
Type of Course	DSC A					
Course Code	M24PH5DSC300					
Course Level	**300**					
Course Summary	Classical and Quantum Mechanics typically covers the fundamental principles and mathematical formalism governing the behavior of physical systems at both classical and quantum scales. Consolidate the understanding of concepts in mechanics such as constraints, degrees of freedom, generalized co- ordinates, Lagrangian, and Hamiltonian. At the introductory level, this course 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 examples. 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.					
Semester	5	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practicum	Others	
		60	0	0		60
Pre-requisites if any	• The students should have a basics understanding of Newtonian Mechanics and elementary Classical mechanics • The students should have basic ideas in electricity and magnetism • The students be familiar with the fundamentals of algebra and trigonometry, vectors, matrices, complex numbers, ordinary differential and integral calculus.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PSO No
CO-1	To memorize the fundamental concepts of Newtonian Mechanics,To define constraints, generalised coordinates, generalised velocities, and generalised force and write Lagrangian for mechanical systems in terms of generalised	R, U, Ap	**1**

	coordinates.		
CO-2	To write Hamiltonian for mechanical systems and derive and solve Hamilton's equation of motion for simple mechanical systems.	R, U, Ap	**1,2**
CO-3	Recognize the limitations of Classical Mechanics and understand the quantum concept-based explanation.	K, U	**2,3,4**
CO-4	Learn the physical and mathematical concepts of quantum physics	U,Ap	**5**
CO-5	Apply the concept of quantum mechanics to derive equations and solve problems	A, An,Ap	**5,6**
CO-6	Application and evaluation of the operators to explain various physical states	U, Ap	**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	**Lagrangian Formulation of Classical Mechanics**		**15**	
	1.1	A brief review of Newtonian mechanics of a particle and a system of particles	1	1
	1.2	Constraints-Types of constraints-Holonomic Constraints, Non-holonomic Constraints, Scleronomous Constraints and Rheonomous Constraints	2	1
	1.3	Generalized Co-ordinates- Degrees of Freedom, Configuration Space and Phase Space	2	1
	1.4	Principle of Virtual Work	1	1
	1.5	D 'Alembert's Principle	1	1
	1.6	Lagrange's Equation from D'Alembert's Principle-Derivation not required	2	1
	1.7	Kinetic Energy in Generalized Co-Ordinates, Generalized Momentum (Conjugate Momentum), Cyclic Co-Ordinates,	2	1
	1.8	Applications of Lagrange's equation in simple pendulum, Linear Harmonic oscillator, Particle	3	1

		Moving Under the Influence of a Central Force (Kepler problem or Planetary Motion), Atwood's Machine		
	1.9	Comparison between Newtonian and Lagrangian Mechanics	1	1
2	**Hamiltonian Formulation of Classical Mechanics**		**15**	
	2.1	Hamilton's Principle, Deduction of Hamilton's Principle	2	2
	2.2	Lagrange's Equation from Hamilton's Principle	2	2
	2.3	Hamiltonian of a System	1	2
	2.4	Hamilton's Equation of Motion (Canonical Equations of Motion) ,	1	2
	2.5	Hamilton's Variational principle - principle of least action - examples	3	2
	2.6	Hamilton's Equations from Variational Principle, Modified Hamilton's Principle	2	2
	2.7	Advantages of Hamiltonian Formalism	1	2
	2.8	Applications of Hamiltonian Method to Physical Problems-Linear Harmonic Oscillator, The Simple Pendulum, Atwood's Machine	3	3
3	**Limitations of Classical Physics and Emergence of Quantum theory**		**15**	
	3.1	Black Body Radiation- Wein's Theory, Rayleigh-Jeans Law, Planck's Radiation Law (Modern Physics Sem 2)	2	4
	3.2	Photoelectric Effect, Compton Effect	2	4
	3.3	Bohr Atom Model	1	4
	3.4	Stability of atoms, Atomic spectra, Correspondence Principle	1	4
	3.5	Wave particle duality, de Broglie Wave, Electron diffraction - Experimental confirmation by Davisson and Germer Experiment	2	5
	3.6	The Uncertainty Principle-Position Momentum Uncertainty, The principle of superposition	2	5

	3.7	Wave Packet, Group Velocity, Phase velocity,	1	6
	3.8	Wave Functions, Properties of Wave function, Statistical Interpretation and Normalisation of Wave Functions	1	6
	3.9	Particle in infinite square well potential (particle in a box), energy levels for particle in a box problem,	2	7
4	**General Formalism of Quantum Mechanics and Schrodinger Equation**		**15**	
	4.1	Linear Vector Space, Linear Operator, -Properties	2	6,9
	4.2	Hilbert space – properties	1	6
	4.3	Eigen Functions and Eigen Values	2	6
	4.4	Hermitian Operator-Properties	2	6,9
	4.5	Postulates of Quantum Mechanics, Expectation value, , Ehren fest's Theorem	4	6
	4.6	Time evolution of wave function, Time-Dependent Schrodinger Equation-For a free particle and for a particle moving in a potential field	2	7
	4.7	Time Independent Schrodinger Equation, Stationary States, Admissibility Conditions on the Wave Function	2	8
5	Teacher Specific Content		To be evaluated internally	

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecturing, Problem Solving, Videos,Simulations
Assessment Types	MODE OF ASSESSMENT A**. Continuous Comprehensive Assessment (CCA)** Theory Total = 30 marks Quiz, Test Papers, seminar
	B**. End Semester Examination** Theory Total = 70 marks, Duration 2 hrs Part A (Short answer) – 10 out of 12 x 2 = 20 marks Part B (Short essay) – 6 out of 9 x 5 = 30 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks

Textbooks

1. Aruldhas G., Classical Mechanics , PHI 2008
2. Aruldhas G, Quantum Mechanics.
3. Quantum Mechanics: Principles & Applications by Devanarayanan S
4. Beiser, Arthur, Mahajan. Shobhit, Choudhury, S. Rai. Concepts of modern physics. McGraw Hill Education, 2017 7th Edition

References

1.Richard P. Feynman, Feynman Lectures on Physics Vol. III, Pearson (2012).

2. Goldstein, Herbert, Poole Charles P., Safko John, Classical Mechanics, 3rd Edition, 2011.

3. Scheck Florian, Mechanics: From Newton's Laws to Deterministic Chaos, 4th Edition 2010.

4. Morin David, Introduction to Classical Mechanics, Cambridge University Press, 2009.

5. Krane, Kenneth S. Modern physics. John Wiley & Sons, 2019.

	Mar Athanasius College **Kothamangalam**

Programme	**BSc Physics (Honours)**					
Course Name	**Elements of Spectroscopy**					
Type of Course	DSC A					
Course Code	**M24PH5DSC301**					
Course Level	**300**					
Course Summary	The course is envisaged to lay the foundation of atomic and molecular spectroscopy and understand how the spectrum arises as radiation interacts with matter. It introduces various spectroscopic techniques and encourages to explore applications.					
Semester	5	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		60		0		60
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	The student should be able to understand the quantum nature of atomic phenomenons	U	1
2	Analyse data to obtain various energy levels	A	1, 2
3	Explain the effect of applied magnetic field on atomic spectral lines	An	1, 2
4	Develop a fundamental knowledge of molecular spectroscopy (microwave, IR and Raman)	U	1, 2
5	Comprehend resonance phenomenon and appreciate MRI technique.	U	1, 2, 3
6	Appreciate spectroscopy as the interaction of radiation with matter and apply the knowledge to analyse a simple spectrum	A	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	**Atomic Spectroscopy**		**20**	
1	1.1	Review of Atomic Physics, Bohr atom model – energy levels and Hydrogen spectra, Absorption and emission spectra, Limitations of Bohr Model	5	1, 2
	1.2	Quantum states of an electron in an atom, Electron Spin, Quantum numbers, Exclusion principle, Orbital and Spin Angular momentum, Space quantisation, Vector atom model	5	1
	1.3	Magnetic moments, Stern- Gerlach experiment, Spectral terms and selection rules, LS and j-j coupling, Fine structure of Sodium D lines	5	1, 2
	1.4	Zeeman effect, Quantum mechanical explanation for normal and anomalous Zeeman effect, Lande g-factor, Paschen- Back effect	5	1, 2, 3
2	**Molecular Spectroscopy**		**15**	
2	2.1	Regions of Electromagnetic Spectrum, Microwave spectroscopy- Classification of molecules based on moment of inertia, Rigid diatomic molecules, rotational energy levels	4	1, 2, 4
	2.2	Infrared spectroscopy- Vibrational energy of diatomic molecules, Harmonic oscillator, vibrational energy levels	3	1, 2, 4
	2.3	Raman Scattering- Classical and Quantum theory of Raman Effect, Stokes and anti- stokes lines Mutual exclusion of IR and Raman spectra	3	1, 2, 4
	2.4	Overview of the spectrometers (μW, IR, Raman), Applications of various spectroscopy methods in material science, environmental science, industry and biological systems (Qualitative)	3	4, 6
	2.5	Electronic transitions- UV and Visible spectra Fluorescence and Phosphorescence	2	1, 6
3	**Resonance Spectroscopy and Activities**		**10**	
3	3.1	NMR Spectroscopy- Basic principles, resonance condition, Instrumentation, Medical applications of NMR.	4	1, 5
	3.2	ESR Spectroscopy- Basic principles and schematics of ESR spectrometer, Instrumentation	4	1, 5

		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	2	6
4	Teacher specific content		To be evaluated internally	

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, Tutorial, Demonstration, Seminars/ Presentations
Assessment Types	MODE OF ASSESSMENT A**. Continuous Comprehensive Assessment (CCA)** Theory Total = 30 marks Quiz, Test Papers, seminar
	B**. End Semester Examination** Theory Total = 70 marks, Duration 2 hrs Part A (Short answer) – 10 out of 12 x 2 = 20 marks Part B (Short essay) – 6 out of 9 x 5 = 30 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks

Text books:

1. Concepts of Modern Physics, Arthur Beiser, 6th Edition, McGraw Hill
2. Fundamentals of Molecular Spectroscopy- C.N. Banwell and E M. McCash , 4th Edition, McGraw Hill
3. Molecular Structure and Spectroscopy, G Aruldhas, Prentice- Hall of India

References:

1. Modern Physics – Murugeshan
2. Introduction to Atomic Spectra, HE White, TMH
3. Spectroscopy: Straughan and Walker –(Vol.1) John Wiley
4. Elements of spectroscopy, Guptha, Kumar and Sharma (Pragathi Prakash)
5. The Feynman Lectures on Physics, Volume III https://www.feynmanlectures.caltech.edu/III_toc.html

	Mar Athanasius College Kothamangalam

Programme	**BSc Physics (Honours)**					
Course Name	**Nuclear and Particle Physics**					
Type of Course	DSC A					
Course Code	M24PH5DSC302					
Course Level	**300**					
Course Summary	This course introduces the fundamental concepts of nuclear and particle physics. The first module comprises the properties of nucleus and nuclear models. The nuclear transformations and nuclear reactions are discussed in the second module. The third gives an introduction to particle physics,fundamental interactions and the dynamics of elementary particles under these forces. Fourth module briefs the biomedical applications and recent advances in module explains the physical principles of various particle accelerators and detectorsThis 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	5	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practicum	Others	
		60	0	0		60
Pre-requisites if any	• The students should have a basics understanding of Newttonian Mechanics and elementary Classical mechanics • The students should have basic ideas in electricity and magnetism • The students be familiar with the fundamentals of algebra and trigonometry, vectors, matrices, complex numbers, ordinary differential and integral calculus.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PSO No
1	To gain knowledge about basic properties of nuclei and details of popular nuclear models for studying nuclear structure behaviour	R, U	1
2	To make use of the laws of nuclear decay for better understanding of related nuclear reaction dynamics	R, U, An	2
3	To familiarize with the fundamental forces and the basic properties and classification of elementary particles.	U, An, Ap	3
4	To discuss about the different radiation counters and detectors	K, U	3,4
5	To solve elementary problems in nuclear and particle physics, and analysing the experimental results	U, A	4,5
6	To discuss about the recent advances in High Energy Physics and few biomedical applications	An, Ap	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	**Nuclear Properties and Models**		**15**	
	1.1	**Nuclear Properties** Nuclear composition, Nuclear properties (Nuclear radii, mass, charge, density, Spin, magnetic moment and Quadrupole moment, parity) Atomic mass unit (u)conversion, Stability curve - Binding energy- Binding energy curve, Nuclear forces- Meson theory of nuclear forces (Yukawa Theory) – Discovery of pion.	7	1
	1.2	**Nuclear Models** Liquid drop model - Semi empirical binding energy formula with correction factors(Bethe Weizsacker Formula) – Applications of the semi-empirical mass formula, Shell model – Magic Numbers-square well potential, simple harmonic oscillator potential, spin-orbit interaction, predictions of shell model(qualitative), limitations of shell model (qualitative)	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, 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** Fundamental Interactions and particle families, Leptons, Neutrinos and Antineutrinos, other leptons, Hadrons, Resonance particles –	4	3,5
		Elementary particle quantum numbers, Quarks, Basic concepts of Quarks – color, flavor, Field Bosons, Standard Model, Quark confinement	3	3,5
	3.2	**Experimental Particle Physics** Different types of radiation detectors - gas ionization, scintillation and semiconductor detectors.	4	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	4	4
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		To be evaluated internally	

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecturing, Problem Solving, Videos,Simulations
Assessment Types	MODE OF ASSESSMENT A**. Continuous Comprehensive Assessment (CCA)** Theory Total = 30 marks Quiz, Test Papers, seminar
	B**. End Semester Examination** Theory Total = 70 marks, Duration 2 hrs Part A (Short answer) – 10 out of 12 x 2 = 20 marks Part B (Short essay) – 6 out of 9 x 5 = 30 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks

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.
3. The Large Hadron Collider – Home page
4. The Relativistic Heavy Ion Collider – Home page

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.

	Mar Athanasius College **Kothamangalam**

Programme	**BSc Physics (Honours)**					
Course Name	**Amplifiers and Oscillators**					
Type of Course	**DSE**					
Course Code	M24PH5DSE300					
Course Level	**300**					
Course Summary	This course aims to get a thorough knowledge of analog IC like operational amplifier and IC 555. It also helps to understand instrumentation techniques and get an idea regarding transducers.					
Semester	5	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		45	0	30	0	75
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PSO No
1	Understand the basics of Analog electronic functions.	K, U	1
2	Analyse different solid-state devices	K,U	1
3	Analyse transistor amplifier circuits	A, An	3,5
4	Describe oscillator circuits	U, A	3, 5
5	Experiential learning by designing the circuit	A, I, Ap	3,5,6

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	**Large Signal Amplifiers**		**12**	
	1.1	Power Amplification: Class A, Class B, Class C Operations	2	1
	1.2	Power rectangle and power efficiency	2	1
	1.3	Class B Push-Pull Amplifier Circuit	2	1,3
	1.4	Complementary Symmetry Push-Pull amplifier and crossover distortion	3	1,3
	1.5	Distortion in Amplifiers: linear and nonlinear distortions	2	1
	1.6	Noise and Noise Figure	1	1
2	**Sinusoidal Oscillators**		**13**	
	2.1	Oscillator circuit and Barkhausen criterion for sustained oscillations,	2	1
	2.2	Tuned Base Oscillator	2	1,4
	2.3	Tuned Collector Oscillator	2	1,4
	2.4	Hartley Oscillator - Colpitt's Oscillator - Clapp Oscillator - Phase Shift Oscillator (derivations not required for all oscillators)	3	1,4
	2.5	Wien Bridge Oscillator.	2	1,4
	2.6	Crystal: piezoelectric effect, equivalent electric circuit, Q-factor, temperature coefficient - Crystal Controlled Oscillators	2	1,2
3	**Nonsinusoidal Oscillators and Field Effect Transistor**		**20**	
	3.1	Nonsinusoidal Waveforms – mark-to-space ratio, pulse repetition time, pulse repetition frequency	2	1,4
	3.2	Classification of Nonsinusoidal Oscillators	2	1,4
	3.3	Multivibrators - Astable Multivibrator	2	4

	3.4	Monostable Multivibrator	2	4
	3.5	Bistable Multivibrator	2	4
	3.6	Schmitt Trigger	2	4
	3.7	**Field Effect Transistor** FET - JFET: Structure, Theory of Operation	3	2
	3.8	JFET Characteristics and JFET Parameters	3	2
	3.9	Common source JFET Amplifier	2	2,3
	3.10	MOSFET - DE MOSFET and E only MOSFET Working and Characteristics	4	2
	Practicals		**30**	5
4	1	FET characteristics: (i) To plot the static drain characteristics of FET (ii) To calculate the FET parameters (drain dynamic resistance, mutual conductance and amplification factor at a given operating point).		
	2	Hartley oscillator: To observe the output wave form and to measure the frequency of oscillations		
	3	Phase shift oscillator: (i) Trace the circuit (ii) To measure the frequency from the output waveform		
	4	Wien Bridge oscillator: To observe the output wave form and to measure the frequency of oscillations		
	5	Astable Multivibrator using transistor- To design and set up an astable multivibrator using UJT for a frequency of 1 kHz.		
	6	Monostable Multivibrator using transistor - To design a monostable multivibrator usingtransistor		
5	Teacher Specific Content		To be evaluated internally	

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Problem Solving and designing circuits Laboratory experiments
Assessment Types	**MODE OF ASSESSMENT** A**. Continuous Comprehensive Assessment (CCA)** Theory Total = 25 marks Quiz, Test Papers, seminar Practical Total = 15 marks Lab performance, record, field report etc.
	B. End Semester Examination Theory Total = 50 marks, Duration 1.5 hrs Part A (Short answer) – 10 out of 12 x1 =10 marks Part B (Short essay) – 4 out of 6 x 5 = 20 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks Practical Total = 35 marks; Duration- 2 hrs Record 10 marks, Examination 25 marks

Text Book:

1. *Basic Electronics Solid State*: B. L. Theraja, S Chand & Company LTD.

References:

1. *Principles of Electronics*, V K Mehta and Rohith Mehta, S Chand & Company LTD.
2. *Electronic Devices and Circuit theory*, Robert Boylestad

	Mar Athanasius College **Kothamangalam**

Programme	**BSc Physics (Honours)**					
Course Name	**Optoelectronics**					
Type of Course	DSE					
Course Code	M24PH5DSE301					
Course Level	**300**					
Course Summary	The course aims to develop an understanding of the physics and applications of modern electronic and optoelectronic semiconductor devices such as LED, photodetectors and solar cells and also optical fibers.					
Semester	5	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		45		30		75
Pre-requisites if any	Basic Solid State Physics, Basic Semiconductor Physics					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the principles and operation of LEDs, photodetectors, and photovoltaic devices, optical fibers and analyze their performance characteristics.	U, An, S	1, 2, 5
2	Apply multidisciplinary approaches in the design and analysis of optoelectronic devices and systems	A, An, S	2, 3, 5, 6
3	Communicate effectively the concepts and applications of optoelectronic devices and systems through oral and written presentations.	S, C, Ap	1, 3, 4, 5
4	Evaluate the social, environmental, and ethical implications of optoelectronic technologies and propose sustainable solutions.	E, An, U, I	1, 4, 5
5	Demonstrate leadership and entrepreneurship skills in the development and implementation of innovative optoelectronic technologies	S, C, A	2, 4, 5

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	**Light Emitting Diodes**		**15**	
	1.1	Homojunction LEDs, Heterostructure High Intensity LEDs, Output Spectrum, Quantum well high density LED s	6	1, 2, 3
	1.2	LED materials, LED structures, LED Efficiencies and Luminous Flux, Basic LED Characteristics, Phosphors and White LEDs	6	1, 2, 3
	1.3	**Photodetectors & Photovoltaic Devices** Absorption Coefficient and Photodetector Materials ,Quantum Efficiency and Responsivity	3	1, 2, 3
2	**Photodetectors & Photovoltaic Devices (contd.)**		15	
	2.2	Principle of the pn Junction Photodiode - Basic Principles , Energy Band Diagrams and Photodetection Modes , Current-Voltage Convention and Modes of Operation	6	1, 2, 3
	2.3	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	1, 2, 3
	2.4	Solar Cell-Basic Principle, Operating Current and Voltage and Fill Factor, Equivalent Circuit of a Solar Cell, Solar Cell Structures and Efficiencies	**4**	1, 4, 5
3	**Optical Fibers**		**15**	
	3.1	Optical Fibre – Total internal reflection - Propagation of light in a fiber - acceptance angle, numerical aperture	8	1, 2
	3.2	Modes of propagation – Classification of fibres - single mode and multimode step index fiber – graded index fiber	5	1, 2
	3.3	V-number - application of optical fibers - LEDs for Optical Fiber Communications – advantages of optical fibers	2	3, 4, 5

4		**Practicals (Any 6)**	**30**	1, 2, 3, 4, 5
	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	Design a photoconductor (LDR) circuit using opamp in the trans impedance mode and study its performance		
	4.5	Study the performance of a photodiode connected in photovoltaic mode using an opamp.		
	4.6	Study the performance of a photodiode connected in photoconductive mode using an opamp.		
	4.7	Compare the performance of a phototransistor connected in common emitter and common collector configurations.		
	4.8	Design a pyroelectric sensor circuit in voltage mode / current mode using an opamp and study its performance.		
	4.9	To characterize the solar cell and find out the FF and Efficiency of a solar Cell.		
	4.10	Construct an optical communication system by transmitting a modulated LED light through an optical fiber and detect the transmitted light intensity using a photodetector.		
	4.11	Determine the current transfer ratio of an Optocoupler (PC817 / 4N35) and draw the input, output and transfer characteristics curves.		
	4.12	Use the optocoupler 6N137 as logic gate and verify its truth table.		
5	Teacher Specific Content		To be evaluated internally	

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 Total = 25 marks Quiz, Test Papers, seminar Practical Total = 15 marks Lab performance, record, field report etc.
	B. End Semester Examination Theory Total = 50 marks, Duration 1.5 hrs Part A (Short answer) – 10 out of 12 x1 =10 marks Part B (Short essay) – 4 out of 6 x 5 = 20 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks Practical Total = 35 marks; Duration- 2 hrs Record 10 marks, Examination 25 marks

Textbook

1. Kasap S.O., Optoelectronics and Photonics: Principles and Practices Pearson Education Ltd. 2nd Edition, 2012.
2. Brij Lal, M. N. Avadhanulu, and N. Subrahmanyam, A Textbook of Optics, S. Chand, 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.

	Mar Athanasius College **Kothamangalam**

Programme	**Physics**					
Course Name	**Computational Physics using Python**					
Type of Course	DSE					
Course Code	M24PH5DSE302					
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	
		45		30		75
Pre-requisites, if any	Nil					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Define fundamental Python syntax, including variables, data types, and basic operators. Memorize and list key control flow structures in Python, such as if statements, loops, and functions.	R	2
2	Explain the concept of object-oriented programming and understand the basic principles of classes and objects in Python. Demonstrate an understanding of Python data structures, including lists, tuples, dictionaries, and sets.	U	2
3	Write and implement Python programs to solve simple computational problems using appropriate data structures and control flow. Apply error handling techniques to identify and resolve common issues in Python code.	A	1,2

4	Analyze and debug simple Python programs by identifying and correcting logical errors and syntax issues. Analyze and optimize code for performance by employing profiling tools and identifying bottlenecks in Python programs.	An	3,5
5	Evaluate and select appropriate data visualization techniques using libraries like Matplotlib and Seaborn for presenting data in Python Evaluate the efficiency of different algorithms and make informed decisions about their implementation in Python.	E	3,5
6	Design and develop Python programs that incorporate modular programming principles, using functions and libraries effectively.	C	3,5
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
	2.2	Various control and looping statements: (if, if..else, if..elif, while, for, break, continue)	**4**	1

	2.3	User defined functions- File input and file output.	**2**	1
	2.4	Concepts of Object-oriented programming	**3**	2
3	**Packages: Math and CMath**		**7**	
	3.1.1	Fundamental Operations: Arithmetic operations (addition, subtraction, multiplication, division)	**2**	
	3.1.2	Exponents and logarithms, Trigonometric functions, Advanced Concepts: Complex numbers, Mathematical constants.	**3**	
	3.1.3	Complex Number Manipulation, Basic operations on complex numbers, Trigonometric and logarithmic functions for complex numbers	**2**	
	Packages: NumPy		**7**	
	3.2.1	Introduction to NumPy: Arrays: creation, indexing, and slicing.	**2**	
	3.2.2	Array operations: element-wise operations, Linear algebra operations with NumPy.	**2**	
	3.2..3	Advanced NumPy Techniques: Random number generation, Universal functions (ufuncs).	**3**	
	Matplotlib		**6**	
	3.3.1	Basic Plotting: Line plots, scatter plots, and bar plots, Customizing plot appearance.	**2**	
	3.3.2	Advanced Visualization: Subplots and multiple plots, 3D plotting, Plotting with external datasets,	**2**	
	3.3.3	Data Visualization Best Practices: Choosing the right plot for the data, Adding labels, titles, and legends, Enhancing clarity with colors and styles	**2**	
4	**Practicals** **(Do not use any built-in packages for doing the problem)**		**30**	Any 6
	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 π(*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	To be evaluated internally	

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 Total = 25 marks Quiz, Test Papers, seminar Practical Total = 15 marks Lab performance, record, field report etc.
	B. End Semester Examination Theory Total = 50 marks, Duration 1.5 hrs Part A (Short answer) – 10 out of 12 x1 =10 marks Part B (Short essay) – 4 out of 6 x 5 = 20 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks Practical Total = 35 marks; Duration- 2 hrs Record 10 marks, Examination 25 marks

Text Books:

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.

	Mar Athanasius College **Kothamangalam**

Programme	**BSc Physics (Honours)**					
Course Name	**Material Characterization Techniques**					
Type of Course	DSE					
Course Code	**M24PH5DSE303**					
Course Level	**300**					
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	5	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		45	0	30	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	1,2
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	1,2
4	To assess the surface morphology, elemental composition, physical properties, and dynamic behaviour of a material by different microscopic methods.	U, A, An	1,2, 3

6	To interpret the thermal properties of a material by using different thermal analysis methods.	U, A, An	1,2
7	To gain a better understanding of different resonance spectroscopic methods.	U, A, An	1,2
8	To analyse the results obtained from the different Material characterisation Techniques.	U, An, E	3, 5, 6
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

Module	Units	Course description	Hrs	CO No.
1	**X-ray Diffraction methods and Spectroscopic Techniques.**		**15**	
	1.1	X-ray diffraction, X-ray radiation, Generation of X-rays, Bragg's law.	3	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.	3	1, 3
	1.5	Fourier Transform Infrared Spectral analysis and Instrumentation	2	3
	1.6	Raman Spectroscopy- Basic idea, Instrumentation and Spectroscopic analysis.	2	3
	1.7	Photoluminescence, Basic principles, Instrumentation.	2	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.	2	4
	2.2	Scanning Electron Microscopy- Instrumentation, Sample requirements, Transmission Electron Microscopy, Instrumentation.	4	4
	2.3	Energy Dispersive Spectroscopy- Energy dispersive spectra analysis. X-ray Photoelectron Spectroscopy, Basic Principle, Energy Referencing, Instrumentation.	4	5

	2.4	Scanning Probe Microscopy, Principle, Instrumentation, Scanning Tunnelling Microscopy, Principle, Instrumentation, Atomic Force Microscopy, Operational Modes.	5	5
3	**Thermal Analysis and Resonance Spectroscopy**		**15**	
	3.1	Thermal Analysis: Common Characteristics, Instrumentation, Experimental parameters.	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	**PRACTICAL: Analysis of different characterisation techniques** (Demonstration and experiment of the available instruments like XRD and UV-Vis spectrometer can be given. 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	To be evaluated internally	
	5.1	Demonstration of the working of instruments like XRD and UV-Vis spectrometer		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Discussions, Demonstrations
Assessment Types	**MODE OF ASSESSMENT** A**. Continuous Comprehensive Assessment (CCA)** Theory Total = 25 marks Quiz, Test Papers, seminar Practical Total = 15 marks Lab performance, record, field report etc.
	B. End Semester Examination Theory Total = 50 marks, Duration 1.5 hrs Part A (Short answer) – 10 out of 12 x1 =10 marks Part B (Short essay) – 4 out of 6 x 5 = 20 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks Practical Total = 35 marks; Duration- 2 hrs Record 10 marks, Examination 25 marks

Textbook

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

References

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

	Mar Athanasius College **Kothamangalam**

Programme	**BSc Physics (Honours)**					
Course Name	**Medical Physics**					
Type of Course	DSE					
Course Code	**M24PH5DSE304**					
Course Level	**300**					
Course Summary	This course deals with the physical phenomenon revolving around the biological systems. The last few years have witnessed a tremendous growth in the applications of Physics to the field of medicine. Beginning with the use of Imaging in Diagnostics to Radiation therapy for Cancer, everything involves Physics. Hence, there is a big need for being aware of medical physics. This course introduces a student to the basics of Medical Physics. Today with the changing life styles it is also necessary for one to have a better understanding of the human body from the perspective of Physics. This course seeks to fulfil both these needs					
Semester	**5**	Credits			**4**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		45	**0**	**30**		**75**
Pre-requisites, if any	Basic concepts of Physics and Chemistry					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PSO No
1	Understand and interpret the fundamentals of physics adds values on biological systems	U	1
2	To promote the application of Physics and understand the anatomy of the different system and its signal measurements	K,U	2
3	Study experimental techniques for making correct and appropriate use of a range of scientific equipment used in biological systems	U,A	2
4	Evaluate the biologic system by making use of experimental techniques in physics	U	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	**Physics of the Body**		**15**	
	1.1	Mechanics of Human Body Basic Anatomical Terminology Skeleton, forces, and body stability. Muscles and dynamics of body movement.	3	1,2
	1.2	Physics of Locomotors Systems: joints and movements, Stability and Equilibrium. Energy household of the body: Energy balance in the body, Energy consumption of the body, Heat losses of the body, Thermal Regulation. Pressure system of body. Physics of breathing, Physics of cardiovascular system. Basics of CPR.	4	1, 2
	1.3	Nature and characteristics of sound, Production of speech, Physics of the ear, Diagnostics with sound and ultrasound Optical system of the body: Physics of the eye.	4	1,2
	1.4	Physics of the nervous system, Electrical signals and information transfer.	4	1,2
2	**Physics of Radiotherapy**		**15**	
	2.1	Overview of Modern Radiotherapy Techniques, Need and Necessity of Quality Assurance Programme in Radiotherapy.	3	3,4,
	2.2	Physical Principles of X-Ray Diagnosis - Interactions of X-Rays with Human Body, Differential Transmission of X-Ray Beam	3	3,4
	2.3	Radiation units exposure, absorbed dose, units: rad, gray, relative biological effectiveness, effective dose-Rem & Sievert, inverse square law. Interaction of radiation with matter Compton & photoelectric effect, linear attenuation coefficient.Radiation Detectors:, chamber. Geiger Muller counter, Scintillation counters and Solid-State detectors, TFT	3	3,4
	2.4	External Beam Therapy (Basic Idea): Telecobalt, Conformal Radiation Therapy (CRT), 3DCRT, IMRT, Image Guided Radiotherapy, EPID, Rapid Arc, Proton Therapy, Gamma Knife, Cyber Knife. Contact Beam Therapy (Basic Idea): Brachytherapy-LDR and HDR, Intra Operative Brachytherapy	3	3,4
	2.5	Radiotherapy, kilo voltage machines, deep therapy machines, Telecobalt machines,Medical linear accelerator. Basics of Teletherapy units, deep X-ray, Telecobalt units, Radiation protection, external beam characteristics, dose maximum and build up – bolus,	3	3,4

		percentage depth dose, tissue maximum ratio and tissue phantom ratio, Planned target Volume and Gross Tumour Volume		
	Radiation and Radiation Protection		**15**	
	3.1	Principles of radiation protection, protective materials-radiation effects, somatic, genetic stochastic and deterministic effect	2	3,4
3	3.2	Personal monitoring devices: TLD film badge, pocket dosimeter, OSL dosimeter.Radiation dosimeter.	2	3.4
	3.3	Natural radioactivity, Biological effects of radiation, Radiation monitors	2	3,4
	3.4	Steps to reduce radiation to Patient, Staff and Public. Dose Limits for Occupational workers and Public. AERB: Existence and Purpose	2	3,4
	Physics of Diagnostic and Therapeutic Systems			
	3.5	Diagnostic nuclear medicine: Radiopharmaceuticals for radioisotope imaging,	2	3,4
	3.6	Radioisotope imaging equipment, Single photon and positron emission tomography.	2	3,4
	3.7	Therapeutic nuclear medicine: Interaction between radiation and matter Dose and isodose in radiation treatment	2	2,3,4
	3.8	Medical Instrumentation: Basic Ideas of Endoscope and Cautery, Sleep Apnea and Cpap Machines, Ventilator and its modes	1	2,3,4
	Practicals		**30**	
	4.1	To study the performance of Biosensor (Pulse measurement technique) https://sl-coep.vlabs.ac.in/exp/performance-bio-sensor/index.html		4
4	4.2	Determine the blood oxygen level and pulse rate using Pulse oximeter, compare the results by placing the oximeter at various parts of the human body		4
	4.3	Determine the blood pressure of human body by Auscultatory Method using BP apparatus at (a) Rest (b) after walking 10 min (c) Jogging 5 min		4
	4.4	Determine the temperature of human body using contact and non-contact thermometer. Compare it by placing on different parts of the body.		4

	4.5	Study of the characteristics of a GM tube and determination of its operating voltage, plateau length/slope		4
	4.6	Estimation of Efficiency of the GM detector for (a) Gamma source (b) Beta source		4
	4.7	Measuring the Diameter of a Human Hair by Laser Diffraction		4
	4.8	Convert a linearly polarized light into elliptically/circularly polarized light using quarter wave plate		4
5		Teacher Specific Content	To be evaluated internally	

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 Total = 25 marks Quiz, Test Papers, seminar Practical Total = 15 marks Lab performance, record, field report etc.
	B. End Semester Examination Theory Total = 50 marks, Duration 1.5 hrs Part A (Short answer) – 10 out of 12 x1 =10 marks Part B (Short essay) – 4 out of 6 x 5 = 20 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks Practical Total = 35 marks; Duration- 2 hrs Record 10 marks, Examination 25 marks

Textbook

1. Biophysics, Vasantha Pattabhi N Goutham, Kluwer Academic Publishers, Newyork, Boston
2. Medical Physics, J.R. Cameron and J.G.Skofronick, Wiley (1978)
3. Basic Radiological Physics Dr. K.Thayalan- Jayapee Brothers Medical Publishing Pvt. Ltd. New Delhi (2003)
4. Christensen‟s Physics of Diagnostic Radiology: Curry, Dowdey and Murry – Lippincot Williams and Wilkins (1990)
5. Physics of the human body, Irving P. Herman, Springer (2007).
6. Physics of Radiation Therapy: F M Khan - Williams and Wilkins, 3rdedition (2003)

7. The essential physics of Medical Imaging: Bushberg, Seibert, Leidholdt and Boone Lippincot Williams and Wilkins, Second Edition (2002)
8. Handbook of Physics in Diagnostic Imaging: R.S.Livingstone: B.I. Publication Pvt Ltd.
9. The Physics of Radiology-H E Johns and Cunningham

	Mar Athanasius College **Kothamangalam**

Programme	**BSc Physics (Honours)**					
Course Name	**Research Methodology**					
Type of Course	SEC					
Course Code	**M24PH5SEC300**					
Course Level	**300**					
Course Summary	By the end of the course, students will have gained proficiency in collecting, analysing, and interpreting experimental data in Physics, preparing them for further studies or careers in scientific research or related fields. The course emphasizes hands-on experience with real-world datasets and practical applications, aiming to equip students with the ability to extract meaningful insights from experimental measurements.					
Semester	5	Credits			3	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		45	0	0		45
Pre-requisites, if any	Basic concepts of Physics and Chemistry					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PSO No
1	Understand of data, bi-variate data, scales of measurement, presentation of data with the help of diagrams and the knowledge of quantitative techniques in the area of statistics.	U	2
2	Understand Research Principles and design research	K,U	2
3	Understand the need for Literature review, Familiarise with different types of journal publications and Literature reviewing.	U,A,An	1,2
4	Enhance skills in communicating research findings and practice ethics in research	U,A	1,2

5	Aim to equip participants with the necessary skills to effectively apply, interpret, and visualize data using Spreadsheet and Origin, Latex software, enabling them to make informed decisions and solve real-world problems efficiently.	U,A	3,4
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	**Collection & Presentation of Data**		**15**	
	1.1	Data collection and analysis – Introduction, Need for data collection Methods of data collection, principles for accessing research data	3	1
	1.2	Data: Quantitative and Qualitative, Attributes, Variables, Scales of Measurement- Nominal, Ordinal, Interval and Ratio.	3	1
	1.3	Presentation of Data by Tables and Diagrams-Tabular and Graphical, Including Bar Diagram, Histogram, Pie Chart, Frequency Polygon and Ogives.Bivariate data: Definition, Scatter Diagram	4	1
	1.4	Frequency Distributions for Discrete and Continuous Variables, Graphical Representation of a Frequency Distribution by Histogram and Frequency Polygon, Cumulative Frequency Distributions.	5	1
2	**Research in Practice**		**15**	
	2.1	Literature review, Need for Literature review, Writing a Literature review;Research ethics – importance, values and principles, plagiarism (basic information only)	4	2,3
	2.2	Publication Types in Journals- Short communication, Rapid communication, Research paper, Review	3	2,3

		paper, Conference Proceedings; Indexing - Journal impact factor, citation index, h- index, g-index, hg-index (basic information only)		
	2.3	Scientific paper – Title, Abstract, Keywords, Introduction, Materials and Methods, Results and Discussion, Conclusion, acknowledgements, References.	4	2,3
	2.4	Writing a scientific paper, Importance of scientific writing, Characteristics of scientific writing, Rules for scientific writing. Communicating to a Journal-Submission methods, Peer review (basic informations only).	4	2,3
	Database and Softwares		**15**	
	3.1	Databases a. Indexing databases b. Citation databases: Web of Science, Scopus, etc.	3	4
	3.2	Research Metrics	3	4
3	3.3	Origin & Spreadsheet: Plotting Data (Linear plot) and adding Error bars;Window control, Formatting figures, Sizing and positioning, Relabeling the X axis	3	5
	3.4	Origin:Least-Squares Fit of a Linear Mode; Use of Origin with a Spread-Sheet Program	3	5
	3.5	Basics of Latex – Document Structure, Typesetting Text, Tables, Figures, Equations, References	3	5
	Research Ethics and Application of Computer in Research		**15**	
4	4.1	Ethical Issues, Ethical Committees, Commercialization, copyright, royalty	2	4
	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.	2	4

	4.3	MS Office and its application in Research – MS Word, MS PowerPoint and MS Excel	2	5
	4.4	Use of the Internet in Research – Websites, Search Engines, E-journal and ELibrary – INFLIBNET.	2	5
	4.5	Using Spreadsheet, calculate the mean, median, mode, range and standard deviation & compute standard deviation, range, skewness of the data organize data in a list alphabetically, numerically or chronologically. Also, construct 2D line chart/2D column chart for a given set of data.	2	3,4
	4.6	Using Spreadsheet, plot Ohm's law.	2	3,4
	4.7	A worksheet contains names and marks in 3 subjects. Calculate total marks and construct 3D Pie chart for total marks.	2	3,4
	4.8	Using Origin, plot data of any spectrum	1	3,4
5		Teacher Specific Content	To be evaluated internally	

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures with hands on training , discussions
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** Theory Total = 25 marks Quiz, Test Papers, seminar
	B. End Semester Examination Theory Total = 50 marks, Duration 1.5 hrs Part A (Short answer) – 10 out of 12 x1 =10 marks Part B (Short essay) – 4 out of 6 x 5 = 20 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks

Textbook

1. Goon A. M., Gupta M. K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I& II, 8th Edn. The World Press, Kolkata.
2. Hogg, R.V., Tanis, E. A. and Rao J. M. (2009): Probability and Statistical Inference, Seventh Ed, Pearson Education, New Delhi.
3. Mood, A. M. Graybill, F. A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rd Edn., (Reprint), Tata McGraw-Hill Pub. Co. Ltd.
4. Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.
5. Vijay K. Rohatgi, A. K. Md. Ehsanes Saleh · 2011,An Introduction to Probability and Statistics, Wiley.
6. Curtis Frye, Microsoft Excel 2019 Step by Step- 250 Ways to a Calmer You ,2019, Microsoft.
7. C.R. Kothari, Research Methodology Methods and Techniques, New Age International Publishers (2013).
8. K.Prathapan, Research Methodology for Scientific Research, I.K International Publishing House Pvt. Ltd. (2014).
9. Latex for beginners Work book 5th edition, Document Reference:3722-2014, March 2014
10. Chaddah, P. (2018) Ethics in Competitive Research: Do not get scooped; do not get plagiarized. ISBN 9387480860
11. Israel, M. (2015). Research Ethics and Integrity for Social Scientists: Beyond Regulatory Compliance. (Second ed.) SAGE Publications Ltd.

References

1. K. F. Riley, M. P. Hobson and S. J. Bence, 2006, Mathematical Methods for Physics and Engineering Third Edition, Cambridge University Press.

Semester: 6

Course Code	Title of the Course		Type of the Course	Credit	Hours/ week	Hour Distribution /week			
						L	T	P	O
M24PH6DSC300	Solid State Physics		DSC A	4	4	4	0	0	0
M24PH6DSC301	Thermodynamics and Introductory Statistical Mechanics		DSC A	4	5	3	0	2	0
M24PH6DSE300	Nonlinear Optics (Photonics)	Any One	DSE	4	4	4	0	0	0
M24PH6DSE301	Introduction to Low dimensional Materials (Sustainable Materials)								
M24PH6DSE302	Biophotonics (Biophysics)								
M24PH6DSE303	Semiconductor Optoelectronic Devices (Electronics)	Any one	DSE	4	5	3	0	2	0
M24PH6DSE304	Sustainable energy Sources (Sustainable Materials)								
M24PH6DSE305	Biophysics and Sports Biomechanics (Biophysics)								
M24PH6DSE306	Science of Sound								
M24PH6DSE307	Exploring the Cosmos								

M24PH6SEC300	Basics of AI and Machine Learning		SEC	3	4	2	0	2	0
M24PH6VAC300	Foundations in Forensic Science	Any one	VAC	3	3	3	0	0	0
M24PH6VAC301	Environmental Physics and Human Rights		VAC	3	3	3	0	0	0

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

	Mar Athanasius College Kothamangalam

Programme	**BSc Physics (Honours)**					
Course Name	**Solid State Physics**					
Type of Course	DSC A					
Course Code	M24PH6DSC300					
Course Level	**300**					
Course Summary	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.					
Semester	6	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		60		0		60
Pre-requisites if any	Basic concepts of Physics and Mathematics					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Demonstrate proficiency in comprehending, solving, and applying major concepts of solid-state physics across all disciplines, including crystal structure, electronic properties, and magnetic properties.	U, An	1, 5
2	Develop systematic problem-solving skills, think independently and methodically, and draw logical conclusions when addressing challenges related to solid-state physics.	U, A	2
3	Apply critical thinking skills and scientific knowledge to understand the concepts in solid-state physics	U, An	3
4	Foster an understanding of the broader implications and impacts of solid-state physics	S, C	4
5	Students will attain competency in both theoretical and experimental aspects of solid-state physics	S, A	5

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**		**15**	
	1.1	Crystal lattice, translation vectors, unit cell, basis	2	1, 3
		Symmetry Operations. Point groups and Space groups.	2	1, 3
		Types of lattices. Indices of a lattice direction and a lattice plane. Interplanar spacing	3	1, 3
		Common crystal structures. Quasicrystals	3	1
		Reciprocal lattice, Properties of reciprocal lattice	2	1, 3
	1.2	X-ray Diffraction - Bragg's law, X-ray diffraction methods	3	1, 2
2	**Free electron theory**		**13**	
	2.1	Drude-Lorentz's classical theory, Sommerfeld's Quantum theory, Fermi-Dirac distribution function, Fermi energy	5	2
	2.2	Static Property: Electronic specific heat	4	2
	2.3	Transport Property: Hall effect, Hall coefficient	4	2
3	**Band theory of Solids, Semiconductors**		**15**	
	3.1	Bloch theorem- Bloch function, Kronig-Penney Model, energy band diagram (E-k diagram), Distinction between Metals, insulators, and semiconductors.	7	1, 2
	3.2	Semiconductors - intrinsic and extrinsic semiconductors - mobility, drift velocity and conductivity of intrinsic semiconductors - Law of mass action - Conductivity for extrinsic semiconductors.	8	1, 2, 3
4	**Dielectric Properties of Solids, Magnetic properties of solids**		**17**	
	4.1	Polarization and Susceptibility, Local field, Dielectric constant and Polarizability, Clausius-Mossotti relation, Sources of polarizability	4	1, 3

	4.2	Ferroelectricity, Ferroelectric domains, Piezoelectricity,	4	1, 3
	4.3	Magnetic terminology, Classification of magnetic materials, Diamagnetism, Paramagnetism.	4	1, 3
	4.4	Ferromagnetism, Ferromagnetic domains, Hysteresis, Antiferromagnetism and Ferrimagnetism	5	1, 3
5		Teacher Specific Content	To be evaluated internally	

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** **Lecture, Presentations, Discussions, Problem solving**
Assessment Types	MODE OF ASSESSMENT A**. Continuous Comprehensive Assessment (CCA)** Theory Total = 30 marks Quiz, Test Papers, seminar
	B**. End Semester Examination** Theory Total = 70 marks, Duration 2 hrs Part A (Short answer) – 10 out of 12 x 2 = 20 marks Part B (Short essay) – 6 out of 9 x 5 = 30 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks

Textbook

1. Puri, R. K., Babbar, V. K. Solid State Physics, S. Chand Publishing 2010.
2. Elements of Solid State Physics, J P Srivastava, PHI Learning, 2015

References

1. Pillai, S.O., Solid State Physics, New Age International Private Limited 10th 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. Ali Omar, M. Elementary Solid State Physics Principles and Applications, Pearson India, 1st Edition 2001

	Mar Athanasius College **Kothamangalam**

Programme	**BSc Physics (Honours)**					
Course Name	**Thermodynamics and Introductory Statistical Mechanics**					
Type of Course	**DSC A**					
Course Code	M24PH6DSC301					
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	
		45	0	30	0	75
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
CO - 1	Get an essence of the fundamental laws of thermal Physics, Thermodynamics and Statistical Mechanics and its significance	U	1,2
CO - 2	Identify the thermal properties, applications of heat transfer, various thermodynamic processes and judge the efficiency of engines by comparing the performance of various vehicles	K, U, A	1,2
CO - 3	Distinguish entropy and available energy in various thermodynamic processes and differentiate between various phase transitions	U, A	1,2

CO - 4	Get an idea of thermodynamic variables, thermodynamic potentials, and its physical significance and hence maxwell's equations	U	1,2
CO - 5	Able to define phase space, microstate, microstate, ensemble and learn to distinguish different statistical distributions and judge which distribution applies to a given system	U, A	1,2
CO-6	To apply the concepts of thermal and statistical physics in experiments and simulations	U,An,A	3,5
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	**TRANSFER OF HEAT (Text Book 1)**		**11**	
	1.1	Thermoelectric effects – Seebeck, Peltier and Thomson effects, Thermoelectric power	2	2
	1.2	Thermal conductivity – Radial flow of heat, cylindrical flow	2	2
	1.3	Black body radiation – Discussion of black body radiation curve, Wein's Displacement Law, Rayleigh - Jeans Law, Planck's Quantum Postulates- Radiation law, Stefan Boltzmann law (Proof not required).	3	1, 2
	1.4	Air conditioning System– Equipment used in Air conditioning system, Classification of Air Conditioning systems- Summer Air conditioning system, Winter Air Conditioning System.	3	1, 2
	1.5	Global Warming – Effects, Efforts to control Global warming	1	2
2	**THERMODYNAMICS (Book 1, 2, 3)**		**18**	
	2.1	Thermodynamic Equilibrium, Equation of state, Hydrostatic systems, Work in changing the volume of hydrostatic system, stretched wire, P V diagram. (Book 2)	4	2
	2.2	First law of thermodynamics, Thermodynamic processes – Isothermal, Adiabatic, reversible, and irreversible, Isobaric and Isochoric, adiabatic expansion of gas, cyclic processes (Basic ideas)	2	1, 2

	2.3	Expression for work done in isothermal and adiabatic process, Carnot's Ideal Heat engine	3	2
	2.4	Petrol engine & Diesel engine – working and efficiency, Multi Cylinder Engines(Book 1), Diesel Engines and Turbochargers (Book3)	4	1, 2
	2.5	Second law of thermodynamics – Clausius and Kelvin - Planck statements, Refrigerator (Qualitative idea)	1	2
	2.6	**ENTROPY (Book 1, 2)** Change in entropy – physical Concept, Change of entropy in reversible and irreversible thermodynamic processes.	1	3
	2.7	Principle of increase of entropy, Heat Death of universe	1	1, 3
	2.8	T -S diagram (Book 2) Change in Entropy for the conversion of ice to steam, Nernst theorem and third law of thermodynamics, Zero-point energy	2	1,3
3	2.9	Basic concept of thermodynamic variables & potentials , Internal energy, enthalpy, Helmholtz free energy, Gibb's free energy – Physical Significance	2	4
	2.10	Relation of thermodynamic Potentials with variables - Maxwell's thermodynamic relations - Clausius - Clapeyron's Latent Heat equation	3	4
	2.11	Change of phase - Phase diagram – first and second order phase transitions	2	4
	STATISTICAL MECHANICS (Text Book 1)		**9**	
	3.1	Statistical Basis – Probability, Principle of equal A priory, probability	1	5
	3.2	Macrostates and Microstates, Phase space	1	5
	3.3	Density of quantum states of energy of a particle	1	5
	3.4	Statistical Ensembles – Microcanonical, Canonical, Grand Canonical	1	5
	3.5	Partition function	1	5
	3.6	Maxwell – Boltzmann statistics- Energy and velocity distribution – Derivation	2	5
	3.7	Need of Quantum statistics, Maxwell - Boltzmann statistics, Bose - Einstein statistics, Fermi - Dirac statistics – Comparative study only	2	5

4		**Practicals**	**30**	6
	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 co-efficient of resistance.		
	5	Electrochemical equivalent of Copper.		
	6	To determine e/k using silicon diode		
	7	Hall Effect in Semiconductor. Determine the Hall coefficient, carrier concentration and carrier mobility		
	8	Measurement of resistivity of a semiconductor by four-probe method at different temperature and determination of band gap.		
	9	Study the temperature dependence of dielectric constant of a ceramic capacitor and verify Curie-Wiess law		
	10	Using any Probability Based Method, estimate the value of pi.		
	11	Simulate one dimensional Ising Model.		
	12	Using Monte Carlo Method, generate a set of particles with speeds distributed according to the Maxwell-Boltzman distribution using Rejection sampling.		
5	Teacher Specific Content		To be evaluated internally	

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 Total = 25 marks Quiz, Test Papers, seminar Practical Total = 15 marks Lab performance, record, field report etc.
	B. End Semester Examination Theory Total = 50 marks, Duration 1.5 hrs Part A (Short answer) – 10 out of 12 x1 =10 marks Part B (Short essay) – 4 out of 6 x 5 = 20 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks Practical Total = 35 marks; Duration- 2 hrs Record 10 marks, Examination 25 marks

Text Book:

1. Brijlal and Subramaniam, *Heat and Thermodynamics* S. Chand &Co.
2. M. Zemansky ,He*at and Thermodynamics* McGraw Hill, New Delhi (2007).
3. Louis A Bloomfield, *" How things works – The Physics of everyday life",* 5th Edition, Wiley Publications (2013)

References:

1. D. S. Mathur, *Heat and Thermodynamics*:, S. Chand & Sons, New Delhi (1995)
2. Sathyaprakash,*Statistical Mechanics,* Kedar Nath Ram Nath, Delhi, Edn (2021).
3. B K Agarwal, Melvin Eisner *Statistical Mechanics,* New Age International (P) Limited, Publishers London – Dew Delhi (2024).
4. S K Sinha, *Introduction to Statistcal Mechanics,* Narosa publishing House Pvt. Limited.
5. Rose C. McCarthy, *Heat and Thermodynamics*:, The Rosen Publishing Group, Inc. NY, (2005).
6. F. W. Sears and G.L. Salinger, *Thermodynamics Kinetic Theory and Statistical Thermodynamics*: Addison-Wesley Publishing Company, 3rd Edn. (1975).
7. S. K. Roy, *Thermal and Statistical Mechanics*: New Age International- 2001

	Mar Athanasius College **Kothamangalam**

Programme	**Physics**					
Course Name	**Nonlinear Optics**					
Type of Course	MAJOR (DSE)					
Course Code	M24PH6DSE302					
Course Level	**300**					
Course Summary	The advent of lasers, particularly ultrashort pulse lasers, has allowed for the exploration of a so-called nonlinear system of interaction between light and matter, revealing a vast wealth of phenomena. This course provides an introduction to nonlinear optics, the branch of optics devoted to studying the interaction between matter and high-power light beams. The course is aimed at all those who wish to deepen their knowledge of optics.					
Semester	6	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		60		0		60
Pre-requisites if any	Good knowledge of optics					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Demonstrate a comprehensive understanding of the transition from linear to nonlinear optics, including the concepts of linear susceptibility, absorption, and refractive index, through theoretical knowledge and numerical simulations using Scilab.	U, A, An, S	1, 5
2	Apply Fourier Transform techniques to analyze optical signals and understand the principles of dispersion, delay, and spectral phase effects in linear optical propagation, both in time and spatial domains.	A, An, S	2, 3
3	Analyze and describe the propagation of light beams in both linear and nonlinear regimes, including the behavior of ultrashort pulses, using the nonlinear propagation equation in time domain	A, An, S	2, 6

4	Explain second and third-order nonlinear processes, such as frequency doubling, three-wave mixing, and the Optical Kerr Effect, including their theoretical background, experimental observation, and practical applications in nonlinear optics.	U, A, An, E, S	1, 4
5	Demonstrate a deep understanding of femtosecond lasers, including their basic principles, relationship with solitons, generation of frequency combs, and applications in nonlinear optics and precision measurements.	U, A, An, E, S	1, 5
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	**Module 1**		18	
		From linear optics to nonlinear optics Simple linear susceptibility model, Absorption and refractive index, Introduction to nonlinear optics, Numerical calculation with Scilab	6	1
		Fourier Transform From series to Fourier transforms, Fourier analysis of a sound signal, group delay and frequency drift, Discrete Fourier transforms with Scilab, Fourier transform of a Gaussian, Demonstration of the Uncertainty Relationship,	6	2
		Propagation in linear regime (time domain) Propagation equation in Fourier space, Dispersion of a short pulse, delay and dispersion measurements, spectral phase effect	6	3
2	**Module 2**		17	
		Propagation in linear regime (spatial domain) Propagation of a monochromatic light beam	4	3
		Propagation in nonlinear regime Case of a superposition of monochromatic waves, Ultrashort pulses: approximation of the slowly varying wave, Non-linear propagation equation in the time domain, Split step method, Importance of symmetry	5	3

		Frequency doubling Second order nonlinear process, Second harmonic in low conversion mode, Linear optics in anisotropic media, Phase agreement by birefringence, Quasi phase agreement	8	4
3	**Module 3**		**13**	
		Three-wave mixing Addition and difference of frequencies, Parametric amplification, Phase agreement by birefringence, Brief foray into the world of quantum optics, Second Harmonic Generation in strong mode	8	4
		Optical Kerr Effect Third-order nonlinear processes, Non-linear propagation equation, Space domain, Time domain, Non-linear Schrödinger equation	5	4
4	**Module 4**		**12**	
		Other Third-order nonlinear effects Absorption saturation, Two-photon absorption, Fluorescence by two-photon excitation, Generation of third harmonic (plane wave), Third harmonic generation in focused geometry, Nonlinear microscopy	7	4
		Femtosecond lasers Basic principle of a femtosecond oscillator, Relationship with solitons, Frequency combs, Amplified systems	5	5
5	Teacher Specific Content		To be evaluated internally	

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** **Lecture, Presentations, Discussions, Problem solving, Simulations, Programming exercises.**
Assessment Types	MODE OF ASSESSMENT A**. Continuous Comprehensive Assessment (CCA)** Theory Total = 30 marks Quiz, Test Papers, seminar

	B**. End Semester Examination** Theory Total = 70 marks, Duration 2 hrs Part A (Short answer) – 10 out of 12 x 2 = 20 marks Part B (Short essay) – 6 out of 9 x 5 = 30 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks

Textbook

1. R.W. Boyd, *Nonlinear Optics*, Academic Press, 3rd Edition
2. Y. R. Shen, "*The Principles of Nonlinear Optics*", Wiley
3. B B Laud, *Lasers and Non-linear Optics*, New Age International, Third Edition, 2011

References

1. YVGS Murti, C Vijayan, *Essentials of Nonlinear Optics*, Wiley 2014.
2. Bahaa E. A. Saleh and Malvin Carl Teich, "*Fundamental of Photonics*", Wiley

	Mar Athanasius College **Kothamangalam**

Programme	**Physics**					
Course Name	**Introduction to Low dimensional Materials**					
Type of Course	**MAJOR** (DSE 3)					
Course Code	M24PH5DSE302					
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	
		60	0	0	0	60
Pre-requisites, if any	Basics of Solid State Physics					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PSO No
1	Understand the significance of length scales in the context of nanomaterials.	Understand	1,2
2	Analyse the key features that distinguish nanosystems from macroscopic systems	Analyse	1.2
3	Understand the behavior of density of states of 2D, 1D and 0D nanomaterials	UnderstandAppreciate	1,2
4	Understand different synthesis methods and characterization of nanomaterials	Understand	1,2
5	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	Understand	1,2
6	Appreciate real-world applications of nanomaterials	Appreciate	1,2

	in electronics, optics, biomedicine, energy, and sensing technologies.		
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	3
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	4

	2.2.2	Plasma arc discharge, sputtering. Evaporation: Thermal evaporation, Electron beam evaporation.	3	4
	2.2.3	Chemical Vapour Deposition (CVD). Pulsed Laser Deposition, Molecular Beam Epitaxy	3	4
	2.2.4	Sol-Gel Technique, Electrodeposition.	2	4
3	**Characterization of Nanomaterials**		**13**	
	3.1	Atomic Structures -Grain size determination – XRD (Debye Scherrer equation)	5	5
	3.2	Microscopy – Scanning Electron Microscope (SEM), Tunneling Electron Microscope (TEM)	5	5
	3.3	Scanning Tunneling Microscope (STM), Atomic Force Microscope (AFM).	3	5
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	6
	4.2	CNT based transistors, Micro Electromechanical Systems (MEMS), Nano Electromechanical Systems (NEMS)	2	6
	4.3	Nano-optics, Biological/bio-medical applications-drug delivery.	2	6
	4.4	Photovoltaic, fuel cells, batteries and energy-related applications, High strength nanocomposites, Nanoenergetic materials, Nanoscale chemical and bio-sensing	4	6
	4.5	Thin film chemical sensors, gas sensors, biosensors	2	6
5	Teacher Specific Content		To be evaluated internally	
	Activity			
	1	Length scales in physics(ppt/report/video)		
	2	Grain size determination using Debye Scherrer formula (using given data)		
	3	Green synthesis of nanoparticles/Detailed study of procedures involved in green synthesis		
	4	Construction of a model of graphene structure		
	5	Resistance measurement of nanofilms		
	6	Estimation of Miller Indices from given data		
	7	Sketch the miller indices of all sides of a cube		
	8	Explore ‘nano in nature’ and make a Presentation		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecturing, Problem Solving, Demonstration/ Powerpoint Presentations
Assessment Types	MODE OF ASSESSMENT A**. Continuous Comprehensive Assessment (CCA)** Theory Total = 30 marks Quiz, Test Papers, seminar
	B**. End Semester Examination** Theory Total = 70 marks, Duration 2 hrs Part A (Short answer) – 10 out of 12 x 2 = 20 marks Part B (Short essay) – 6 out of 9 x 5 = 30 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks

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

	Mar Athanasius College **Kothamangalam**

Programme	**BSc Physics (Honours)**					
Course Name	**Biophotonics**					
Type of Course	DSE					
Course Code	M24PH6DSE302					
Course Level	**300**					
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	6	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		60		0		60
Pre-requisites if any	General Physics, Basic knowledge of Optics					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Demonstrate proficiency in understanding the principles and science of the interaction of light with cells and tissues	U	1
2	Develop systematic problem-solving skills and independently choose suitable biomedical imaging techniques for diverse applications, drawing logical conclusions when addressing physics-related challenges.	U, A	2
3	Develop critical thinking skills and scientific knowledge to effectively design, execute, document, and analyze the outcomes of experiments in tissue engineering using light, thereby fostering an understanding of the broader impacts of physics.	U, C	6
4	Evaluate and appraise different optical biosensors and their implications, demonstrating proficiency in comprehending and applying major concepts of physics.	U, E	3
5	Understand the material properties of photosensitizers used for photodynamic therapy, attaining professional competency in both theoretical and experimental aspects.	U	5

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 with and tissues,	6	1
	1.2	Photo-process in Biopolymers- human eye and vision,	2	1
	1.3	Photosynthesis	2	5
	1.4	Photo-excitation- free space propagation, optical fibre delivery system, articulated arm delivery, hollow tube wave-guides. Optical biopsy.	5	4
2	**Bio-imaging**		**15**	
	2.1	Overview of optical imaging, Kohler illumination, phase contrast microscopy, dark-field and differential interference contrast microscopy,	5	1
	2.2	Fluorescence, confocal and multi-photon microscopy,	3	1
	2.3	Optical Coherence Tomography	2	4
	2.4	FRET imaging, exogeneous and endogeneous fluorophores as bioimgaing probes	5	5
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	5
	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	1
	4.2	manipulation of single DNA molecules, molecular motors, laser microbeams for Genomics and Proteomics,	4	4
	4.3	semiconductor Quantum dots for bioimaging, Metallic nano-particles and nano-rods for bio-sensing,	4	5
	4.4	Photonics and biomaterials; bacteria as bio-synthesizers for photonics polymers	3	4
5	Teacher Specific Content		To be evaluated internally	

Teaching and Learning Approach	Classroom Procedure (Mode of transaction) Lecture, Presentations, Discussions
Assessment Types	MODE OF ASSESSMENT A**. Continuous Comprehensive Assessment (CCA)** Theory Total = 30 marks Quiz, Test Papers, seminar
	B**. End Semester Examination** Theory Total = 70 marks, Duration 2 hrs Part A (Short answer) – 10 out of 12 x 2 = 20 marks Part B (Short essay) – 6 out of 9 x 5 = 30 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks

Textbooks

1. Paras N Prasad, Introduction to Biophotonics, Wiley 2004

References:

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

Mar Athanasius College Kothamangalam

Programme	**BSc Physics (Honours)**					
Course Name	**Semiconductor Optoelectronic devices**					
Type of Course	**DSE**					
Course Code	**M24PH6DSE303**					
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	**A. Continuous Comprehensive Assessment (CCA)** Theory Total = 25 marks Quiz, Test Papers, seminar Practical Total = 15 marks Lab performance, record, field report etc.
	B. End Semester Examination Theory Total = 50 marks, Duration 1.5 hrs Part A (Short answer) – 10 out of 12 x1 =10 marks Part B (Short essay) – 4 out of 6 x 5 = 20 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks Practical Total = 35 marks; Duration- 2 hrs Record 10 marks, Examination 25 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.

	Mar Athanasius College **Kothamangalam**

Programme	**Physics**					
Course Name	**Sustainable Energy Resources**					
Type of Course	DSE					
Course Code	**M24PH6DSE304**					
Course Level	**300**					
Course Summary	This course explores the impact of energy sources on global warming and examines approaches to energy conservation and governmental policies. Moreover, this course also covers different energy sources like solar, wind, hydro, tidal, and wave energy. The course touches upon other energy sources, storage methods and provides a broad overview of energy systems and technologies.					
Semester	6	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		45	0	30		75
Pre-requisites, if any	Basic concepts of Physics and Chemistry					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PSO No
1	Get an introduction to the different energy resources	U	4
2	Understand that these sources can play a very important supportive role in addition to conventional energy resources	K,U	2
3	Understand the energy planning, policy making and consumption.	U,A,An	4
4	Introduce the fundamental physical processes governing various energy technology and applications.	U	3
5	Stresses scientific understanding, analysis and applications of non-conventional energy technology	A,An,S	4

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 Energy Science**		**15**	
	1.1	Classification of Energy resources –common forms of energy-its merits and demerits- importance of non-conventional energy sources – and its salient features	5	1
	1.2	Global Energy Scenario: availability of energy: conventional and non-conventional resources – Impact Due to Non-Conventional Energy Sources – Global Warming	5	1, 2, 3
	1.3	Energy scenario in India – availability of energy: conventional and non-conventional resources. Approaches to Energy Conservation - Energy Conservation Policies of Different Governmental Bodies	5	2,3
2	**Solar Energy**		**15**	
	2.1	Solar Energy: Solar Solar Radiation Solar Spectrum, Extraterrestrial and Terrestrial radiation, Solar time, Solar day, hour angle, Intensity of solar radiation,Measurements (qualitative only), , Solar Cell Technology (basic principle only)	4	1,4,5
	2.2	Solar thermal energy collector, Flat plate collector, Concentration type collector	4	1,4,5
	2.3	Principles of the Conversion of Solar Radiation into Heat Solar Heaters, Solar Green Houses, Merits and Demerits of Solar Energy,	4	1,4,5
	2.4	Solar cell fundamentals, solar photovoltaics – PN junction based solar cells, study of I-V and L-I-V characteristics, calculation of efficiency and fill factor,	3	1,4,5
3	**Other Renewable Energy Sources**		**15**	
	3.1	Wind Energy:Basics, Principles of Wind Energy Conversion, Merits and Demerits, Basic Components of Wind Energy Conversion System, Policies Related to Wind Energy in India, Applications of Wind Energy.	3	5
	3.2	Introduction of geothermal energy and its applications – types of geothermal resources – Exploration and its development – Geothermal energy in India.	4	5
	3.3	Hydro, Tidal and Wave Energy: Hydro-Resources, Hydro-Project- Types and Hydro-Conversion Technologies Tidal Resource, Tidal Power	4	5

		Conversion Wave Resource, Wave Energy Conversion		
	3.4	Bio-Mass Energy: Photosynthesis – Biomass forms, composition and fuel properties – Biomass resource-conversion methods- Urban waste to energy conversion-Biomass gasification – Biomass liquification – Biogas production from waste biomass	4	5
	Practicals		**30**	
	4.1	Plot sun chart and locate the sun at your location for a given time of the day	3	5
	4.2	Thermo emf analysis - Verification of thermoelectric laws	4	5
	4.3	Efficiency and fill factor of solar cell.	4	5
4	4.4	Photo transistor characteristics.	4	5
	4.5	V-I characteristics of a solar cell.	3	5
	4.6	Energy Audit at your home/college/village	8	5
	4.7	Design and build a solar cooker using materials like cardboard, aluminum foil, and glass	2	5
	4.8	Demonstration of Training modules on Solar energy.	2	5
5		Teacher Specific Content	To be evaluated internally	

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** **Lecture, Presentations, Discussions**
Assessment Types	**A. Continuous Comprehensive Assessment (CCA)** Theory Total = 25 marks Quiz, Test Papers, seminar Practical Total = 15 marks Lab performance, record, field report etc.

	B. End Semester Examination Theory Total = 50 marks, Duration 1.5 hrs Part A (Short answer) – 10 out of 12 x1 =10 marks Part B (Short essay) – 4 out of 6 x 5 = 20 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks Practical Total = 35 marks; Duration- 2 hrs Record 10 marks, Examination 25 marks

Textbook

1. Energy Technology: S. Rao and Dr. B.B. Parulekar, Third edition, 2009.
2. Non-conventional Energy Resources by B.H.Khan.
3. Alternative Energy Resources, Green Energy and Technology, Efstathios E. (Stathis) Michaelides, Springer, 2012, DOI 10.1007/978-3-642-20951-2.
4. Non-Conventional Energy Sources, Sri. Shali Habibulla, State Institute of Vocational Education Directorate of Intermediate Education Govt. of Andhra Pradesh, Hyderabad, 2005.
5. Non-Conventional Energy Resources: G. D. Rai, Khanna Publishers, 2008.
6. Solar Energy Fundamentals and application: H.P. Garg and J. Prakash, Tata McGraw - Hill Publishing company Ltd., 1997.
7. Non-conventional Energy Resources by G.D. Rai.

References

1. World Issues - Energy Crisis, S Chand Publishing, ISBN : 9788121933391
2. Understanding the Global energy crisis, Edited by Eugene D. Coyle and Richard A. Simmons, ISBIN: 978-1-55753-661-7, Purdue University Press, USA
3. Power Plant Technology: A. K. Wahil. 1993.
4. Solar energy: S. P. Sukhatme, Tata McGraw- Hill Publishing company Ltd.,1997.
5. Renewable Energy, Power for a sustainable future, Godfrey Boyle, 2004, Oxford University Press, in association with The Open University.
6. Solar Energy: Resource Assessment Handbook, Dr. P Jayakumar, 2009.

	Mar Athanasius College Kothamangalam

Programme	**BSc Physics (Honours)**					
Course Name	**Biophysics and Sports Biomechanics**					
Type of Course	**DSE**					
Course Code	**M24PH6DSE305**					
Course Level	**300**					
Course Summary	Focusses on the physical principles behind sports, with the purpose of enabling the student to develop and optimize ideas on sports.					
Semester	**6**	**Credits**			**4**	**Total Hours**
Course Details	**Learning Approach**	**Lecture**	**Tutorial**	**Practical**	**Others**	
		45	**0**	**30**	**0**	**75**
Pre-requisites, if any	**Nil**					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No
1	Understand the fundamental scientific concepts of body mechanics.	U	1
2	Understand basic concepts in physics and interpret relation connecting with sports and know how to use them effectively in tournaments	U	1,2
3	Realize the concept and its application on sports	U, A, An	3
4	Develop the ability to read, evaluate, and interpret numerical and general sports data and apply physical principles to real-world sporting situations	A, An,E	3,4

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	**Mechanics of Human Body**		**15**	
	1.1	Definition of Biomechanics & Sports Biomechanics Importance of Biomechanics for Sports technique	2	1
	1.2	Goals of Sports Biomechanics – Performance Enhancement, Technique, Equipment, Training, Injury Prevention and Rehabilitation	2	1
	1.3	Distribution of mass in Human body Forces in muscles and bones – elastic properties – work, energy and power of the body	2	1
	1.4	Introduction of Clinical Biomechanics; Concept of Clinical Biomechanics Chiropractic Technique	1	1
	1.5	Strength and food requirements – calculation of calorific content needed for each sports person	1	1
	Physics of Running and Jumping			
	1.6	Athletics - Physics of Running, Long jump, High Jump & Gymnastics	2	2
	1.7	Analysis of Track Techniques: Starting, running, hurdling, stride length, frequency, sprint length, frequency and sprint start	2	2,3
	1.8	Analysis of Field Techniques: Standing broad jump, running broad jump, pole vault-techniques involved- guiding principles	2	2,3
2	**Kinetic Study of Bats and Balls**		**15**	
	2.1	Science Behind the Design of Bats - Table Tennis, Cricket, Tennis, Cricket Bowling-Magnus Effect, Spin Motion, Reverse Swing	4	2
	2.2	Analysis Of Cricket/Base Ball: Impact – moment of inertia – spin – size of the ball-size of the bat – batting – stride- swing – bunting.	4	2,3

	2.3	Analysis Of Tennis Techniques: Grip- striking – serve – direction of flight of ball – guiding principles	4	2,3
	2.4	Projectiles – horizontal and vertical motion- range of projectile – trajectory – Analysis of throwing events: techniques involved in speed of release, angle of release and reverse in shot-put, discus, javelin and hammer throw-	3	3
	The Gymnastics and Adventure Sports		**15**	
	3.1	Eccentric force-moment – equilibrium – centre of gravity – weight – rotator and circular motion	4	2
	3.2	Analysis of Gymnastics activities: Analysis of rope climb,	3	3,4
3	3.3	Swimming And Diving: Basic ideas of flotation –buoyant force – centre of buoyancy – specific gravity - relative motion – fluid resistance – conservation of momentum Analysis of swimming techniques	4	2,3,4
	3.4	Diving techniques Other Factors Influencing Performance: Air resistance – spin or gyration – available force – human characteristics – effects of gyroscopic action – guiding principles.	4	2,3,4
	Practicals		**30**	
	4.1	Calculation of Center of Gravity by Suspension Method		4
	4.2	Determination of center of gravity of human body under resting and working conditions.		4
4	4.3	Basics of Cinematography method and Videography in Sports		4
	4.4	Use of KINOVEA Software (Analysis of Fundamental Movement)		4
	4.5	Field Setting during Data Collection in Motion Analysis		4
	4.6	Calculation of Force using Force platform		4

	4.7	Different types of Camera; Features of Camera; Position of Camera (Height, Tripod, Light, Frame Per Second, Shutter Speed, Pixel, Resolution etc)		4
	4.8	Biomechanical study of work posture, joint angle study, determination of spinal curvature, analysis of posture by video graphic method – OWAS, REBA, RULA, OCRA etc.		4
5		**Teacher specific content**		**To be evaluated internally**

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, Demonstration, Ground and Sports Events Visit, Observation and interactive Session, Group discussion.
Assessment Types	**MODE OF ASSESSMENT** **A.Continuous Comprehensive Assessment (CCA)** Theory Total = 25 marks Quiz, Test Papers, seminar Practical Total = 15 marks Lab performance, record, field report etc.
	B. End Semester Examination Theory Total = 50 marks, Duration 1.5 hrs Part A (Short answer) – 10 out of 12 x1 =10 marks Part B (Short essay) – 4 out of 6 x 5 = 20 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks Practical Total = 35 marks; Duration- 2 hrs Record 10 marks, Examination 25 marks

Textbooks

1. The Biomechanics of Sports Technique, Third Ed. Hay. G. James .
2. Scientific Principles of Coaching, Second Ed..
3. The Physics of Sports A Textbook by David R..

References

(1) Concepts in physics by H C Verma

(2) https://science.howstuffworks.com/engineering/architecture/brunelleschis-dome.htm

(3) General Physics with Bioscience Essays, Marion and Noryak, Second Ed,

	Mar Athanasius College **Kothamangalam**

Programme	**BSc Physics (Honours)**					
Course Name	**Science of Sound**					
Type of Course	DSE					
Course Code	M24PH6DSE306					
Course Level	**300**					
Course Summary	This course is an introduction to sound and its interaction with humans and matter in the world around us. The physics of sound waves as well as the fundamental physical properties of sound will be briefed here. Hands on experiment and simulation to analyse the physical properties of sound is also included					
Semester	4	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		45	0	30		75
Pre-requisites, if any	Basic concepts of Physics and Mathematics					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PSO No
1	To familiarise physical nature and characteristics of waves	U	1,4
2	To explain about the perception and interpretation of sound by human ear	K,U	2.4
3	To analyse the characteristics of sound waves	U,A,An	3,5
4	To understand about the acoustics and factors affecting acoustics	U	3,4,5
5	To explain the audio measurement methods	U	5,6
6	To apply the basic theories of sound in real life situations	A,An,S	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	**Waves and the characteristics**		**15**	
	1.1	Wave theory – Sine wave, Transverse and Longitudinal wave, Sound as a pressure wave, Propagation of sound wave through medium	3	1
	1.2	Waveform characteristics – Amplitude, Frequency, Wavelength, Time-period, Velocity, Phase; Sound and density	3	1
	1.3	Simple and complex wave, Fundamental frequency, Harmonics and Overtones, Partials, Octave, Timbre;	5	1
	1.4	Different waveform types – Sine, Square, Triangle, Saw-tooth; Sound Envelope – ADSR	4	1
2	**Human Ear, Sound and Acoustics**		**15**	
	2.1	Structure of ear – outer, middle and inner ear;	1	2,3
	2.2	Perception of pitch, critical bands, Dynamic Range of Hearing, Equal Loudness Contour and Flecter- Munson curve, Protective mechanism of Ear	3	2,3
	2.3	Sound waves and their characteristics: Loudness, how loudness is measured, Decibel, intensity of a sound. Acoustics- acoustic powers of different sources of sound, pitch, quality of sound, Noises and Musical sound, Doppler effect, , Sound production and perception, Physics of music and musical instruments Physical characteristics of sound – reflection, absorption, refraction diffraction, diffusion;	6	2,3
	2.4	Acoustics: Architectural acoustics, reverberation, acoustical demands on an auditorium, reverberation time and absorption coefficient. Sabine's law	5	4
3	**Audio Measurements**		**15**	
	3.1	Peak and RMS, Linear and Logarithmic scale ,Decibel ,Sound pressure level, Sound pressure to dB scale, Decibel equations, Inverse-square law;	3	5
	3.2	SPL measurements, Threshold of hearing, Threshold of pain,	2	5

	3.3	Weighing Networks, Metering – VU & PPM, dBm, dBu, dBA, dBV, dBFS, LUFS, standard levels for interconnecting audio equipments	6	5
	3.4	Dynamic Range, S/N Ratio, Headroom, Pink and White Noise	4	5
	Practical			
4	4.1	To find the Speed of Sound in air at room temperature using a resonance tube by two resonance Positions		6
	4.2	Simulate the phenomenon of beats using two harmonic waves		6
	4.3	Using a stop-watch, measure the period of oscillations of a mass on a spring for different values of its mass *m*, spring stiffness *k*, and the amplitude *A*.		6
	4.4	To construct a square wave from a sinusoidal wave by adding overtones		6
	4.5	Understand doppler effect in sound by Measuring Frequency in Linear Motion using a stationary audio source, and a mobile phone running the Phyphox app.		6
5		Teacher Specific Content	To be evaluated internally	

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** **Lecture, Presentations, Discussions**
Assessment Types	**MODE OF ASSESSMENT** A**. Continuous Comprehensive Assessment (CCA)** Theory Total = 25 marks Quiz, Test Papers, seminar Practical Total = 15 marks Lab performance, record, field report etc
	B. End Semester Examination Theory Total = 50 marks, Duration 1.5 hrs Part A (Short answer) – 10 out of 12 x1 =10 marks Part B (Short essay) – 4 out of 6 x 5 = 20 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks Practical Total = 35 marks; Duration- 2 hrs Record 10 marks, Examination 25 marks

Textbook

1. Modern Recording Techniques – David Miles Huber
2. D. R. Khanna and R. S. Bedi, A Textbook of Sound, Atma Ram and Sons, 1992

References

1. Sound and Recording – Francis Rumsey
2. Acoustics and Psychoacoustics - Howard Davis M, James Angus

	Mar Athanasius College Kothamangalam

Programme	**BSc Physics (Honours)**					
Course Name	**Exploring the Cosmos**					
Type of Course	**DSE**					
Course Code	**M24PH6DSE307**					
Course Level	**300**					
Course Summary	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					
Semester	6	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		45	**0**	**30**	**0**	**75**
Pre-requisites, if any	Knowledge of Basic Mathematics and Physics					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	To locate sky objects by their right ascension and declination on the celestial sphere.	U, A	1, 2
2	To explain the apparent daily and annual motions of the Sun	U, An	1, 3
3	To explain the different types of telescopes and their features	U	1, 2
4	Compare and contrast the stages of evolution of stars based on mass	U, An	1, 3

5	To explain the process of energy production in stars	U	1, 2
6	To gain a basic understanding of the 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; Plancks 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 Total = 25 marks Quiz, Test Papers, seminar Practical Total = 15 marks Lab performance, record, field report etc.
	B. End Semester Examination Theory Total = 50 marks, Duration 1.5 hrs Part A (Short answer) – 10 out of 12 x1 =10 marks

	Part B (Short essay) – 4 out of 6 x 5 = 20 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks Practical Total = 35 marks; Duration- 2 hrs Record 10 marks, Examination 25 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.

	Mar Athanasius College **Kothamangalam**

Programme	**Physics**					
Course Name	**Basics of AI and Machine Learning**					
Type of Course	SEC					
Course Code	M24PH6SEC300					
Course Level	**300**					
Course Summary	The objective of this course is to equip Physics undergraduate students with practical skills in AI and 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	
		30	0	30	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 AI and machine learning and its application in Physics	U, A	1,2, 3
2	Explain different learning techniques in AI and machine learning	U	1,2, 3
3	Make use of clustering on raw data	U, A	1,2, 3
4	Evaluate the performance of classification methods	A, An, E	1,2, 3
5	Understand various search algorithms, such as uninformed search and informed to solve problems in artificial intelligence and other related fields	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 Artificial Intelligence**		**10**	
	1.1	Concept of AI, History, Current Status and Scope, Intelligent Agents and Environments	1	1
	1.2	Problem Formulations Review of Tree and Graph Structures	2	1
	1.3	State Space Representation, Search Graph, Search Tree	1	1
	1.4	Definition of Knowledge, Representation and Organization of Knowledge	2	1,2
	1.5	Random Search, Search with Closed and Open List, Depth First Search, Breadth First Search	2	1,2
	1.6	Heuristic Search, A* Algorithm, Concepts of Game Playing, Expert Systems	2	1,2
2	**Introduction to machine learning**		**10**	
	2.1	Introduction, Machine learning versus traditional programming. How machine learning works, Applications of machine learning	2	1,2
	2.2	Types of machine learning	2	2
	2.3	Types of regression, linear regression- multiple linear regression, Non-linear regression and logistic regression	3	2
	2.4	Classification, Decision trees, Naive Bayes Support vector machine, K-nearest neighbours, Random forest	3	2
3	**Cluster and multivariate analysis**		**10**	
	3.1	Requirements of clustering, types of data in cluster analysis	2	3
	3.2	Categorization of clustering algorithms, partitioning methods	2	3
4	3.3	Dimensionality reduction- Factor analysis Reinforcement learning	2	3

	3.4	Introduction, applications of deep learning, Types of deep learning algorithms, Multilayer.	2	3,4
	3.5	CNN- training using tensor flow	2	4
		Practicals	30	
	4.1	Implementation of toy problems		5
	4.2	Developing agent programs for real world problems		5
	4.3	Implementation of constraint satisfaction problems		5
	4.4	Implementation and Analysis of DFS and BFS for an application		5
	4.5	Developing Best first search and A* Algorithm for real world problems		5
	4.6	Implementation of minimax algorithm for an application		5

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures with hands on training , discussions
Assessment Types	**MODE OF ASSESSMENT** A. **Continuous Comprehensive Assessment (CCA)** Theory Total = 15 marks Quiz, Test Papers, seminar Practical Total = 15 marks Lab performance, record, field report etc.
	B. End Semester Examination Theory Total = 35 marks, Duration 1 hrs Part A (Short answer) – 10 out of 12 x1 =10 marks Part B (Short essay) – 3 out of 6 x 5 = 15 marks Part C (Long essay) – 1 out of 2 x 10 = 10 marks Practical Total = 35 marks; Duration- 2 hrs Record 10 marks, Examination 25 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/

	Mar Athanasius College **Kothamangalam**

Programme	**Physics**					
Course Name	**FOUNDATIONS IN FORENSIC SCIENCE**					
Type of Course	**VAC**					
Course Code	M24PH6VAC300					
Course Level	**300**					
Course Summary	The "Foundations in Forensic Science" course is a comprehensive and interdisciplinary exploration of key areas in forensic investigation. Through this course, students can delve into the fundamental principles and techniques essential to modern forensic science. Beginning with an overview of forensic science's role in crime investigation, students progress to mastering, evidence collection, and identification. It will also explain students with the specific techniques to be used for the examination of forensic evidences The course would apprise students with the basics of forensic photography techniques					
Semester	**6**	**Credits**			**3**	**Total Hours**
Course Details	**Learning Approach**	**Lecture**	**Tutorial**	**Practical**	**Others**	
		45	**0**	**0**	**0**	**45**
Pre-requisites, if any	**Nil**					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No
1	Understand the basic concept, meaning, significance and development of Forensic science	U	1
2	To elucidate research methodologies and techniques used in the formation of research design on a specific problem	U	1,2
3	Understand the common types of physical evidence encountered at crime scenes and summarize its significance as well as summarize principles of crime scene reconstruction.	K, U, A	3
4	Describe Crime scene investigations, Reconstruction of scene of crime,basic principles of photography and its relevance	A, An	5

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 of Foresenic Science**		**15**	
	1.1	Introduction, Concepts and Significance of Forensic Science, History and Development of Forensic Science	3	1
	1.2	Laws and Basic principles of Forensic Science	4	1
	1.3	Branches of forensic science, Organizational set-up of a Forensic Science Laboratory	4	1
	1.4	Functions of Forensic Scientist - Analysis of Physical Evidence, The Importance of Physical Evidence, Determining Admissibility of Evidence, Providing Expert Testimony.	4	1
2	**Tools and techniques in Forensic Science**		**15**	
	2.1	Evaluation -Tools and Techniques, Microscopy, Micro Chemical Tests, X-ray Diffraction, Micro-FTIR Spectroscopy	3	2
	2.2	Measuring and optical instruments	2	2
	2.3	Research methodologies. Formation of research design on a specific problem. Forensic Problems	2	2
	2.4	Example of a Specific Trace Evidence - Glass - Importance, Nature, Location, Evaluation.	2	3
	2.5	Common Types of Physical Evidence	2	3
	2.6	The Significance of Physical Evidence - Identification, Comparison, Individual Characteristics, Class Characteristics, Assessing the Value of Physical Evidence, Cautions and Limitations in Dealing with Physical Evidence.	2	3
	2.7	Crime Scene Reconstruction - Principles of Crime- Scene Reconstruction, Personnel Involved in Reconstruction.	2	3
3	**Forensic Photography**		**15**	

	3.1	Basic principles of Photography, Techniques of black & white and color photography, cameras, lenses, shutters, depth of field, film	4	4
	3.2	Exposing, development and printing techniques; Different kinds of developers and fixers;	4	4
	3.3	UV, IR, fluorescence illumination guided photography	4	4
	3.4	Modern development in photography- digital photography, working and basic principles of digital photography	3	4
4		**Teacher specific content**	**To be evaluated internally**	

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, Observation, Interactive, Group discussion, Field Visit
Assessment Types	**MODE OF ASSESSMENT** A. **Continuous Comprehensive Assessment (CCA)** Theory Total = 25 marks Quiz, Test Papers, seminar
	B. End Semester Examination Theory Total = 50 marks, Duration 1.5 hrs Part A (Short answer) – 10 out of 12 x1 =10 marks Part B (Short essay) – 4 out of 6 x 5 = 20 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks

Textbooks

1. Criminalistics: An Introduction to Forensic Science, Richard Saferstein, (12/e), Pearson Education Inc.
2. Forensic Science in Criminal Investigation and trials, Dr. BR.Sharma, (4/e), Universal Law Publishing Co. Pvt. Ltd.
3. Fundamentals of Forensic Science, Houck, M.M & Siegel, J.A;, Acadamic Press, London,2006.
4. Forensic Science in India- A vision for the Twenty First Century Nanda B.B and Tewari, R.K;, Select Publisher, New Delhi, 2001.

References

1. Crime Investigation, Paul L Kirk, Wiley
2. Solving Crimes with Physics, Carla Miller Nozigia, Mason Crest Publishers
3. Beginners Forensic Science, Dr. C. Hegde & Dr. R. Shekhar, Himalaya Publishing House.
4. Crime Scene Forensics: A Scientific Method Approach, Robert C Shaler, CRC Press
5. Fundamentals of Forensic Science, Max M. Houck & Jay A. Siegel, Elsivier Science.

	Mar Athanasius College **Kothamangalam**

Programme	**FYUGP**					
Course Name	**Environmental Physics and Human Rights**					
Type of Course	**VAC**					
Course Code	**M24PH6VAC301**					
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.					
Semester	**6**	**Credits**			**3**	**Total Hours**
Course Details	**Learning Approach**	**Lecture**	**Tutorial**	**Practical**	**Others**	
		45	**0**	**0**	**0**	**45**
Pre-requisites, if any	**Nil**					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PSO No
1	To understand the basics of the ecosystem, biodiversity, renewable and non-renewable resources.	U	1
2	To achieve Sustainable development goals by positively correlating the environment with human communities.	U,A,An,E	1, 2, 3, 4
3	To value the environmental policies and practices after analyzing the environmental pollution and its adverse effects.	U, A, An	1, 2, 4
4	To reframe the concepts and methods to safeguard the environment.	U,A,An,E	1, 2 , 3
5	To develop an understanding of human rights in global and national perspective.	U,A, An	1, 4
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	**Unit1:Introduction to environmental studies**		**5**	
	1.1	Multidisciplinary nature of environmental studies	1	1
	1.2	Scope and importance; Concept of sustainability and sustainable development.	2	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)	3	1
1	**Unit2: Natural Resources: Renewable and Non-renewable Resources**		**10**	
	1.4	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	2
	1.5	Water: Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter-state).	4	2
	1.6	Energy resources: Renewable and non-renewable energy sources, use of alternate energy sources, growing energy needs, case studies.	2	2
2	**Unit1: Environmental Pollution and Environmental Policies & Practices**		**15**	
	2.1	Environmental pollution: types, causes, effects and controls; Air, water, soil and noise Pollution, Nuclear hazards and human health risks	6	3
	2.2	Solid waste management: Control measures of urban and industrial waste, Pollution case studies	3	3
	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;	4	4

		Wildlife Protection Act; Forest Conservation Act. International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD).		
	2.4	Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context.	2	4
3	**Unit 1: Human Rights**		**15**	
	3.1	An Introduction to Human Rights, Meaning, concept and development	2	5
	3.2	History of Human Rights-Different Generations of Human Rights- Universality of Human Rights-Basic International Human Rights Documents - UDHR ,ICCPR,ICESCR.-Value dimensions of Human Rights	3	5
	3.3	Human Rights coordination within UN system-Role of UN secretariat- The Economic and Social Council- The Commission Human Rights-	2	5
	3.4	The Security Council and Human rights (Brief idea only)-The Committee on the Elimination of Racial Discrimination- The Committee on the Elimination of Discrimination Against Women-the Committee on Economic, Social and Cultural Rights- The Human Rights Committee-	3	5
	3.5	Human Rights in Indian Constitution – Fundamental Rights- The Constitutional Context of Human Rights-directive Principles of State Policy and Human Rights	2	5
	3.6	Human Rights of Women-children –minorities-Prisoners- Science Technology and Human Rights- National Human Rights Commission-State Human Rights Commission- Human Rights Awareness in Education.	3	5
4		**Activities**		
	4.1	Write a report on the cause and effect of any one pollution in your locality.Mention the remedies to reduce the effects.	1	4
	4.2	Discuss the recent climatic conditions of Kerala.	1	4
	4.3	Present case studies of environmental movements in India as a group activity.	1	1,4
	4.4	Discussion on environmental protection acts in India.	1	4
	4.5	Discuss alternative energy sources to meet world's growing energy demands.	1	4

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** 1. Lecture method 2. Case Study Method 3. Assignment 4. Interactive Session 5. Group discussion
Assessment Types	**MODE OF ASSESSMENT** A. **Continuous Comprehensive Assessment (CCA)** Theory Total = 25 marks Quiz, Test Papers, seminar
	B. End Semester Examination Theory Total = 50 marks, Duration 1.5 hrs Part A (Short answer) – 10 out of 12 x1 =10 marks Part B (Short essay) – 4 out of 6 x 5 = 20 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks

References

1. Odum, Eugene Pleasants, and Gary W. Barrett. *Fundamentals of ecology*. Vol. 3. Philadelphia: Saunders, 1971.
2. Non-conventional energy sources - G.D Rai- Khanna Publishers, New Delhi
3. Bharucha Erach, Text Book of Environmental Studies for undergraduate Courses. University Press, IInd Edition 2013 (TB)
4. Pepper, Ian, Charles P. Gerba, and Mark L. Brusseau. *Environmental and pollution science*. Elsevier, 2011.

Human Rights

5. Amartya Sen, The Idea Justice, New Delhi: Penguin Books, 2009.
6. Chatrath, K. J.S., (ed.), Education for Human Rights and Democracy (Shimla: Indian Institute of Advanced Studies, 1998)
7. Law Relating to Human Rights, Asia Law House, 2001.
8. Shireesh Pal Singh, Human Rights Education in 21st Century, Discovery Publishing House Pvt.Ltd, New Delhi,
9. S.K.Khanna, Children and the Human Rights, Common Wealth Publishers, 1998. 2011.
10. Sudhir Kapoor, Human Rights in 21st Century, Mangal Deep Publications, Jaipur, 2001.
11. United Nations Development Programme, Human Development Report 2004: Cultural Liberty in Today's Diverse World, New Delhi: Oxford University Press, 2004

SUGGESTED READINGS

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: 7

Course Code	Title of the Course	Type of the Course	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
M24PH7DCC400	Statistical Physics	DCC	4	5	3	0	2	0
M24PH7DCC401	Mathematical Physics	DCC	4	4	4	0	0	0
M24PH7DCC402	Electrodynamics	DCC	4	4	4	0	0	0
M24PH7DCE400	Atomic and Molecular Physics	DCE	4	4	4	0	0	0
M24PH7DCE401	Nanophotonics							
M24PH7DCE402	Energy Conversion and Storage Systems							
M24PH7DCE403	Advanced Classical Mechanics							
M24PH7DCE404	Research and Professional Ethics							
M24PH7DCE405	General Relativity and Applications							

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

	Mar Athanasius College Kothamangalam

Programme	**BSc Physics (Honours)**					
Course Name	**Statistical Mechanics**					
Type of Course	**DCC**					
Course Code	M24PH7DCC400					
Course Level	**400**					
Course Summary	Statistical mechanics is branch of physics that deals with understand collective response from the single particle behavior. This course explains how the statistical approach is effective in predicting the thermodynamics of 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.					
Semester	7	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		45	0	30	0	75
Pre-requisites, if any	Nil					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PSO No
1	Analyse statistical systems in thermal equilibrium. Apply quantum and classical methods for ideal statistical systems	K, U	1,2
2	Explain statistical physics and thermodynamics as a logical consequence of the postulates of statistical mechanics	U, A	1,2
3	Perform quantitative calculations and formulate models of realistic systems	A, E, An	1,2
4	Analyse different systems such as ideal gas, Fermi gas, Bose gas and evaluate phase transitions	U, An, E	1,2
5	Develop and apply Ising model and mean field theory for first and second order phase transitions.	U, A	1,2
6	To apply the concepts of statistical Physics to experiments and simulations	A,S	1,3, 5

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	**Fundamental of Thermodynamics and Foundations of Statistical Mechanics**		**22**	
	1.1	**Fundamental of Thermodynamics** Fundamental definitions – different aspects of equilibrium – functions of state	**1**	**1**
	1.2	Internal energy – reversible changes – enthalpy – heat capacities – reversible adiabatic changes in an ideal gas	**1**	**1**
	1.3	Second law of thermodynamics – the Carnot cycle - equivalence of the absolute and the perfect gas scale of temperature	**1**	**1**
	1.4	Definition of entropy- measuring the entropy – law of increase of entropy – calculations of the increase in the entropy in irreversible processes – the approach to equilibrium.	**2**	**1**
	1.5	**Foundations of Statistical Mechanics** Ideas of probability – classical probability – statistical probability – the axioms of probability theory – independent events – counting the number of events	**1**	**1**
	1.6	Statistics and Distributions Basic ideas of statistical mechanics	**1**	**1**
	1.7	Definition of the quantum state of the system Simple model of spins on lattice sites – equations of state.	**2**	**1**
	1.8	The second law of thermodynamics	**1**	**1**
	The Canonical Ensemble and Statistics of Identical Particles			
	1.9	**The Canonical Ensemble** A system in contact with a heat bath – the partition function – definition of the entropy in the canonical ensemble	2	3
	1.10	The bridge to thermodynamics through partition function – condition for thermal equilibrium – thermodynamic quantities from partition function	2	3

	1.11	Case of a two level system – single particle in a one dimensional box – single particle in a three dimensional box – expression for heat and work	2	3
	1.12	Rotational energy levels for diatomic molecules Vibrational energy levels for diatomic molecules	2	3
	1.13	Factorizing the partition function – equipartition theorem – minimizing the free energy.	1	3
	1.14	Identical particles – symmetric and antisymmetric wave functions - bosons –fermions	1	3
	1.15	Calculating the partition function for identical particles – spin –identical particles localized on lattice sites.	2	3
2	**Maxwell Distribution, Planck's Distribution and Grand Canonical Ensemble**		**12**	
	2.1	**Maxwell Distribution and Planck's Distribution** The probability that a particle is in a quantum state – density of states in k space	1	3
	2.2	Single particle density of states in energy – distribution of speeds of particles in a classical gas	1	3
	2.3	Blackbody radiation – Rayleigh-Jeans theory –Planck's distribution – derivation of the Planck's distribution – the free energy	2	3
	2.4	Einstein's model vibrations in a solid – Debye's model of vibrations in a solid.	2	3
	2.5	**Grand Canonical Ensemble** Systems with variable number of particles – the condition for chemical equilibrium	2	3
	2.6	The approach to chemical equilibrium – chemical potential –reactions – external chemical potential	2	3
	2.7	Grand canonical ensemble –partition function – adsorption of atoms on surface sites – grand potential.	2	3
3	**Fermi and Bose Particles, Phase Transitions**		**11**	
	3.1	**Fermi and Bose Particles** Statistical mechanics of identical particles – thermodynamic properties of a Fermi gas	1	4
	3.2	Examples of Fermi systems – non-interacting Bose gas	2	4
	3.3	**Phase Transitions** Phases– thermodynamic potential – approximation	2	4
	3.4	First order phase transition - Clapeyron equation	1	4
	3.5	Phase separation – phase separation in mixtures – liquid gas system	1	4

	3.6	Ising model order parameter	2	5
	3.7	Landau theory- symmetry breaking field	1	5
	3.8	Critical exponents	1	5
4	**Practicals**		30	
	1	Study the temperature dependence of the dielectric constant of a ceramic capacitor and verify Curie-Wiess law		6
	2	Thermal conductivity using dynamic method		6
	3	Fermi energy of a semiconductor		6
	4	To determine e/k using silicon diode		6
	5	Using Monte Carlo Method, generate a set of particles with speeds distributed according to the Maxwell-Boltzman distribution using Rejection sampling.		6
	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.		6
	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.		6
	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.		6
		Teacher Specific Content	To be evaluated internally	

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecturing, Problem Solving.
Assessment Types	**MODE OF ASSESSMENT** A**. Continuous Comprehensive Assessment (CCA)** Theory Total = 25 marks Quiz, Test Papers, seminar Practical Total = 15 marks Lab performance, record, field report etc.
	B. End Semester Examination Theory Total = 50 marks, Duration 1.5 hrs Part A (Short answer) – 10 out of 12 x1 =10 marks Part B (Short essay) – 4 out of 6 x 5 = 20 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks Practical Total = 35 marks; Duration- 2 hrs Record 10 marks, Examination 25 marks

Text Book:

1.Introductory Statistical Mechanics, R. Bowley & M. Sanchez, 2nd Edn. 2007, Oxford University Press, Indian Edition.

Reference Books:

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

	Mar Athanasius College Kothamangalam

Programme	**BSc Physics (Honours)**					
Course Name	**Mathematical Physics**					
Type of Course	**DCC**					
Course Code	M24PH7DCC401					
Course Level	**400**					
Course Summary	This course Practice the method of contour integration to evaluate definite integrals of varying complexity. Also introduces the concepts of Laplace, Fourier transforms and the Fourier series. Get introduced to Special functions like Gamma function, Beta function, and other functions and their recurrence relations.					
Semester	7	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practicum	Others	
		60	**0**	**0**		**60**
Pre-requisites, if any	Basic Mathematics					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PSO No
1	To practice the method of contour integration to evaluate definite integrals of varying complexity	A, An	1, 2
2	To Learn the fundamentals and applications of Fourier series, Fourier and Laplace transforms,their inverse transforms.	U, A	1, 2
3	To Get introduced to Special functions like Gamma function, Beta function, Bessel functions and their recurrence relations	U, An, A, E	1, 2, 3
4	To solve second order differential equations using Frobenius method	U, A, An	1, 2
5	To Solve partial differential equations using different methods.	U, A	1, 2
6	To apply the method of Green's function to solve linear differential equations with inhomogeneous term	U, 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	**Complex analysis**		**15**	
	1.1	Functions of a complex variable - Analytic functions - Cauchy-Riemann equation -	3	1
	1.2	Integration in a complex plane - Cauchy Theorem - Cauchy's integral formulas -	4	1
	1.3	Taylor expansion & Laurent expansion	3	1
	1.4	Residue, poles - Cauchy residue theorem - Cauchy's principle value theorem - Evaluation of integrals	5	1
2	**Integral transforms**		**15**	
	2.1	Fourier Series - Application of Fourier series - Square Wave - Full Wave Rectifier.	4	2
	2.2	Fourier Transform - Finite Wave Train - Momentum representation - Hydrogen atom - Harmonic oscillator	4	2
	2.3	Laplace Transform, Inverse Laplace transform	4	2
	2.4	Earth Nutation - Damped Oscillator - LCR circuit	3	2
3	**Special functions and differential equations**		**15**	
	3.1	Gamma Function - Beta Function - Symmetry Property of Functions - Evaluation of Beta functions - Other forms of Beta Functions	4	3
	3.2	Transformation of Beta Functions - Evaluation of Gamma Functions - Other forms of Gamma Functions- Transformation of Gamma Functions - Relation between Beta and Gamma Functions - Evaluation of Integrals -	3	3
	3.3	Bessel's Differential Equation- Legendre Differential Equation - Associated Legendre Differential Equations - (Generating function, recurrence relation, orthogonality condition, for all functions), Rodrigues formula-equation Only	4	4

	3.4	Hermite Differential Equations - Laguerre Differential Equations Generating function, recurrence relation, orthogonality condition-Hermite Differential equation, Rodrigues formula-equation Only	4	4
4	**Partial differential equations**		**15**	
	4.1	Characteristics of boundary conditions for partial differential equation - Solution of partial differential equations by the method of separation of variables in Cartesian, cylindrical and spherical polar co-ordinates	8	5, 6
	4.2	Solution of Laplace equation in cartesian, cylindrical and spherical polar co-ordinates - Heat equation in Cartesian co-ordinates - Non-Homogeneous equation - Green's function - Symmetry of Green's Function - Green's Function for Poisson Equation.	7	5, 6
5		Teacher Specific Content	To be evaluated internally	

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecturing, Problem Solving
Assessment Types	MODE OF ASSESSMENT A**. Continuous Comprehensive Assessment (CCA)** Theory Total = 30 marks Quiz, Test Papers, seminar
	B**. End Semester Examination** Theory Total = 70 marks, Duration 2 hrs Part A (Short answer) – 10 out of 12 x 2 = 20 marks Part B (Short essay) – 6 out of 9 x 5 = 30 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks

Textbook

1. Mathematical Physics, Satya Prakash, S. Chand & Sons.
2. Mathematical Physics, H.K. Dass, S. Chand & Co. New Delhi.
3. Mathematical methods for Physicists, G.B. Arfken& H.J. Weber 5th edition, Academic Press.

References

1. Mathematical Physics, B.S.Rajput, Y.Prakash 9th edition Pragati Prakashan
2. Mathematical Physics,B.D.Gupta ,Vikas Publishing House
3. Mathematical Physics , P.K.Chatopadhyay ,New Age International Publishers
4. Advanced Engineering Mathematics E.Kreyszig 7thedition John Wiley

	Mar Athanasius College **Kothamangalam**

Programme	**BSc Physics (Honours)**					
Course Name	**Electrodynamics**					
Type of Course	DCC					
Course Code	M24PH7DCC402					
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 makes the students to gain an understanding of radiation from localized time varying electromagnetic sources. It also helps the students to analyse different phenomena that involves relativistic electrodynamics.					
Semester	7	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	60
		60	0	0	0	60
Pre-requisites, if any	Student should be familiar with electromagnetic theory					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PSO No
1	To describe the nature of electromagnetic wave and its propagation through different media	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	1,2,3
4	To gain the concepts of relativistic electrodynamics and its applications in branches of Physical Sciences	U	1,2,5
5	To make use of 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		**Time Varying Fields**	**15**	
	1.1	Electromagnetic induction and Faraday's law	2	1
	1.2	Maxwell's displacement current, Maxwell's equations in free space and linear isotropic media	3	1
	1.3	Boundary conditions on the fields at interfaces, time dependent scalar and vector potentials	2	1
	1.4	Gauge invariance, Coulomb and Lorentz Gauge	2	2
	1.5	Magnetic field energy, conservation laws,	2	2
	1.6	Continuity equation, Poynting's theorem,	2	2
	1.7	Maxwell's stress tensor and conservation of momentum	2	2
2		**Guided waves**	**15**	
	2.1	Electromagnetic waves in free space, Dielectrics and conductors	3	1,2
	2.2	Reflection and refraction at interfaces	2	1,2
	2.3	Waveguides and transmission lines, Transmission line equations and wave characteristics	3	1,2
	2.4	Skin effect, Modes in rectangular wave guide	2	1,2
	2.5	Guided waves – waves between parallel conducting plane TE, TM and TEM waves	3	1,2
	2.6	TE and TM Waves in Rectangular wave guides	2	1,2
3		**Electromagnetic radiation**	**15**	

	3.1	Continuous charge distribution-Retarded potential-Jefmenko's equation	2	3
	3.2	Point charges- Lienard-Wiechert potentials- Field of a point charge in motion- Power radiated by a point charge	2	3
	3.3	Electric Dipole Radiation	3	3
	3.4	Magnetic Dipole Radiation	3	3
	3.5	Radiation from arbitrary distribution of charges	3	3
	3.6	Radiation reaction-Abraham-Lorentz formula	2	3
4		**Relativistic Electrodynamics**	**15**	
	4.1	Relativistic electrodynamics	2	4,5
	4.2	Lorentz transformation equations, Lorentz invariance of Maxwell's equations	3	4,5
	4.3	Transformations of electromagnetic fields under Lorentz transformation	2	4,5
	4.4	Electrodynamics in tensor notation	2	4,5
	4.5	Potential formulation of relativistic electrodynamics.	2	4,5
	4.6	Four potential of a field	2	4,5
	4.7	Dynamics of charged particles in static and uniform electromagnetic fields	2	4,5
5		Teacher Specific Content	To be evaluated internally	

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** **Lecture , Demonstration, Assignments, Discussion**
Assessment Types	MODE OF ASSESSMENT A**. Continuous Comprehensive Assessment (CCA)** Theory Total = 30 marks Quiz, Test Papers, seminar
	B**. End Semester Examination** Theory Total = 70 marks, Duration 2 hrs Part A (Short answer) – 10 out of 12 x 2 = 20 marks Part B (Short essay) – 6 out of 9 x 5 = 30 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks

Textbooks

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

	Mar Athanasius College **Kothamangalam**

Programme	**BSc Physics (Honours)**					
Course Name	**Atomic & Molecular Physics**					
Type of Course	DCE					
Course Code	M24PH7DCE400					
Course Level	**400**					
Course Summary	The course is envisaged to lay the foundation of atomic and molecular spectroscopy and understand how the spectrum arises as radiation interacts with matter. It introduces various spectroscopic techniques and encourages to explore applications.					
Semester	7	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		60		0		60
Pre-requisites, if any	Quantum Mechanics					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Achieve advanced knowledge about the interactions of electromagnetic radiation and matter and their applications in spectroscopy	U, A	1, 2
2	Analyse data to obtain various energy levels	A	1, 2
3	Explain the change in behavior of atoms in external applied electric and magnetic field	U, A, An	1, 2
4	Develop a fundamental knowledge of molecular spectroscopy (microwave, IR and Raman)	U	1, 2
5	Comprehend resonance phenomenon and appreciate MRI technique.	U	1, 2
6	Master both experimental and theoretical working methods in atomic and molecular physics for making correct evaluations and judgments	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	Hours	CO No.
1	**Atomic Spectroscopy**		**18**	
1	1.1	The quantum mechanical treatment of hydrogen atom- quantum numbers n, l and ml; spectra of alkali metal vapours	3	1, 2
	1.2	Derivation of spin-orbit interaction energy in hydrogenlike atoms; extension to penetrating orbits; fine structure in sodium atom	3	1, 2
	1.3	Normal Zeeman effect; Anomalous Zeeman effect- magnetic moment of the atom and g factor; spectral frequencies; Lande g-formula.	3	2, 3
	1.4	Paschen–Back effect – splitting of sodium D-lines; Stark effect	2	2, 3
	1.5	L S coupling scheme -spectroscopic terms arising from two valence electrons; terms arising from two equivalent s-electrons; derivation of interaction energy -combination of s and p electrons; Hund's rule, Lande interval rule.	4	2, 3
	1.6	The jj coupling scheme in two electron systems - derivation of interaction energy- combination of s and p electrons ;Hyperfine structure (qualitative idea only)	3	2, 3,6
2	**Microwave and Infrared Spectroscopy**		**16**	
2	2.1	Classification of molecules- linear, symmetric top, asymmetric top and spherical top molecules	2	4
	2.2	Rotational spectra of rigid diatomic molecules; intensity of spectral lines	2	2, 4
	2.3	Effect of isotopic substitution; energy levels and spectrum of non–rigid rotor	3	2, 4
	2.4	Vibrational energy of a diatomic molecule-simple harmonic oscillator –energy levels; diatomic molecule as anharmonic oscillator-energy levels; infrared selection rules; spectrum of a vibrating diatomic molecule.	4	2, 4
	2.5	Diatomic vibrating rotator –P and R branches; break down of Born-Oppenheimer approximation.	3	2, 4
	2.6	Vibrations of polyatomic molecules – fundamental vibrations and their symmetry	2	2, 4
3	**Raman Spectroscopy and Electronic Spectroscopy**		**15**	

3	3.1	Quantum theory of Raman effect; classical theory-molecular polarizability ;Pure rotational Raman spectra of linear molecules	3	2, 4
	3.2	Raman activity of vibrations; rule of mutual exclusion; vibrational Raman spectra ;rotational fine structure	3	2, 4
	3.3	Structure determination from Raman and IR spectroscopy.	2	6
	3.4	Non- linear Raman effects - hyper Raman effect - classical treatment	2	4
	3.5	Electronic spectra of diatomic molecules –Born-Oppenheimer approximation, vibrational coarse structure-progressions and sequences; intensity of spectral lines- Franck – Condon principle	3	4
	3.6	Rotational fine structure of electronic-vibrational transition ; Fortrat parabola; Predissociation.	2	4
4	**Spin Resonance Spectroscopy**		**16**	
4	4.1	Nuclear Magnetic Resonance(NMR)-resonance condition ; relaxation processes - Bloch equations	3	5
	4.2	Chemical shift ; indirect spin–spin interaction	2	5
	4.3	CW NMR spectrometer; Magnetic Resonance Imaging.	2	5
	4.4	Electron Spin Resonance(ESR)- Principle of ESR; thermal equilibrium and relaxation; ESR spectrometer; characteristics of the g-factor	3	5
	4.5	Total Hamiltonian for an electron; Hyperfine Structure- ESR spectrum of hydrogen atom	2	5
	4.6	Mossbauer effect - recoilless emission and absorption; Experimental techniques in Mossbauer spectroscopy	2	5
	4.7	Isomer shift; quadrupole interaction; magnetic hyperfine interaction.	2	5
5	Teacher specific content		To be evaluated internally	

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 Total = 30 marks Quiz, Test Papers, seminar

	B**. End Semester Examination** Theory Total = 70 marks, Duration 2 hrs Part A (Short answer) – 10 out of 12 x 2 = 20 marks Part B (Short essay) – 6 out of 9 x 5 = 30 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks

References

1. Introduction to Atomic Spectra, HE White, TMH
2. Fundamentals of Molecular Spectroscopy- C.N. Banwell and E M. McCash , 4th Edition, McGraw Hill
3. Molecular Structure and Spectroscopy, G Aruldhas, Prentice- Hall of India

Suggested Readings

1. Spectroscopy: Straughan and Walker –(Vol.1) John Wiley
2. Elements of spectroscopy, Guptha, Kumar and Sharma (Pragathi Prakash)
3. Concepts of Modern Physics, Arthur Beiser, 6th Edition, McGraw Hill
4. Modern Physics – Murugeshan

	Mar Athanasius College **Kothamangalam**

Programme	**BSc Physics (Honours)**					
Course Name	**NANOPHOTONICS**					
Type of Course	MAJOR -DSE					
Course Code	M24PH7DCE401					
Course Level	**400**					
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	7	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4				60
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PSO 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	2,3,4
3	To examine plasmonic effects in metal nanoparticles	U,A	5,6
4	To understand the different applications of Nanophotonics	U, Ap	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	**Foundations of nanophotonics**		**15**	
1	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
	Quantum confined materials		**15**	
2	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
	Plasmonics		**15**	
3	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

	Applications		**15**	
4	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 Nanophores For Bioimaging, Biosensors, self -cleaning glasses	4	4
5	Teacher Specific content		To be evaluate internally	

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** **Lecture, Presentations, Discussions**
Assessment Types	MODE OF ASSESSMENT A**. Continuous Comprehensive Assessment (CCA)** Theory Total = 30 marks Quiz, Test Papers, seminar
	B**. End Semester Examination** Theory Total = 70 marks, Duration 2 hrs Part A (Short answer) – 10 out of 12 x 2 = 20 marks Part B (Short essay) – 6 out of 9 x 5 = 30 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks

Textbook

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

References

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

	Mar Athanasius College **Kothamangalam**

Programme	**BSc Physics (Honours)**					
Course Name	**Energy Conversion and Storage Systems**					
Type of Course	DCE					
Course Code	M24PH7DCE402					
Course Level	**400**					
Course Summary	This course aims to develop researchers who can provide fundamental inputs required to meet the challenges of a sustainable energy future. Energy storage solutions are receiving high marks in the energy sector. Energy storage is a useful tool to support grid electrical supply, transmission and distribution systems.					
Semester	7	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		60	0	0	0	60
Pre-requisites, if any	Basic concepts of Physics and Chemistry					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the basic concept of energy storage devices	U	1
2	Students will have the ideas in energy conversion methods.	K,U	1
3	To foster the creation of new and relevant technologies and to transfer them to industry for effective utilization.	U,A	2,6
4	Utilization and application of energy storage systems in various sectors and industries like automotive, electronics and energy.	U	2,5
5	Detail practical knowledge in energy storage systems and conversion process of battery electric vehicles.	A,An	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	**Basics of Energy Storage**		**15**	
	1.1	Introduction to power system and technologies. Demand variation and forecasting. Grid features. Siting and costing.	5	1,2
	1.2	Renewable energy: solar, geothermal, wind, biomass, ocean, fuel cells, unique features of decentralized systems	5	1, 2
	1.3	Co-generation systems. Environmental issues, sustainability and future scenarios	5	1,2
2	**Hydrogen and Fuel Cell**		**15**	
	2.1	Hydrogen Energy Economy – Conception - Present status and a vision –Applications of Hydrogen - Transport application - cars, light trucks, buses - Stationary and Portable - Electronic gadgets. Hydrogen – Physical and chemical properties - Salient characteristics	3	3,4
	2.2	Production of hydrogen – Steam reforming – Water electrolysis – Gasification and woody biomass conversion – Biological hydrogen production – Photo dissociation – Direct thermal or catalytic splitting of water.	3	3,4
	2.3	Hydrogen storage options – Compressed gas – Liquid hydrogen – Hydride – Chemical Storage – Comparisons - Transport of Hydrogen - Pipelines, Gaseous, Liquid and Compound materials.	3	3,4
	2.4	FUEL CELLS: History – Principle - Working - Thermodynamics and kinetics of fuel cell process – Performance evaluation of fuel cell – Comparison on battery Vs fuel cell - Types of fuel cells – AFC, PAFC, SOFC, MCFC, DMFC, PEMFC – Relative merits and demerits.	3	3,4
	2.5	APPLICATION OF FUEL CELL: Fuel cell usage for domestic power systems - Large scale power generation – Automobile - Space - Environmental analysis of usage of Hydrogen in Fuel cell - Future trends in fuel cells.	3	3,4
3	**Other Energy Technologies and its Storage**		**15**	
	3.1	An introduction on Thermal energy storage systems Thermoelectric power conversion- Magneto Hydrodynamic power conversion – Thermionic power	3	4,5

		conversion		
	3.2	Piezoelectric Energy Harvesting – Physics and Characteristics of Piezoelectric Effect, Piezoelectric Energy Applications	4	4,5
	3.3	Electrochemical (supercapacitors) & Electromagnetic (Superconducting Magnetic Energy storage) energy storage systems	4	4,5
	3.4	BATTERY ELECTRIC VEHICLES: BEVs-Introduction-battery types-the cost of electricity-BEV requirements and design-flow batteries-history of BEVs-rechargeable sodium batteries	4	4,5
	Biomass Energy		**15**	
	4.1	Biomethanation: Microbial systems, phases in biogas production	3	4,5
4	4.2	Parameters affecting gas production	3	4,5
	4.3	Biogas plants, types, design, constructional details and comparison	3	4,5
	4.4	Biogas appliances, Burner, illumination and power generation, effect on engine performance	3	4,5
	4.5	Combustion, Gasification,Pyrolysis and Carbonization	3	4,5
5		Teacher Specific Content	To be evaluated internally	

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** **Lecture, Presentations, Discussions**
Assessment Types	MODE OF ASSESSMENT A**. Continuous Comprehensive Assessment (CCA)** Theory Total = 30 marks Quiz, Test Papers, seminar
	B**. End Semester Examination** Theory Total = 70 marks, Duration 2 hrs Part A (Short answer) – 10 out of 12 x 2 = 20 marks Part B (Short essay) – 6 out of 9 x 5 = 30 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks

Textbook

1. Richard a. Dunlap sustainable energy, Cengage Learning; 1st edition (2014)
2. Linden D. and Reddy Thomas B., "Handbook of Batteries", 2001, McGraw Hill Publications.

3. S. Srinivasan, Fuel Cells: From Fundamentals to Applications, Springer (2006)
4. Jochen Fricke, Walter L. Borst, Essentials of Energy Technology: Sources, Transport, Storage, Conservation 1st Edition, Wiley, (2014).
5. O'Hayre, S. W. Cha, W. Colella and F. B. Prinz, Fuel Cell Fundamentals, Wiley (2005).
6. J. Bard and L. R. Faulkner, Electrochemical Methods: Fundamentals and Applications, 2nd Edition.

References

1. Hydrogen and Fuel Cells: A Comprehensive Guide, Rebecca L. and Busby, Penn Well Corporation, Oklahoma, (2005).
2. Hydrogen and Fuel Cells: Emerging Technologies and Applications, Bent Sorensen (Sorensen), Elsevier, UK, (2005).
3. David Boyles, (1984) Bio Energy Technology Thermodynamics and costs, Ellis Hoknood Chichester
4. Khandelwal, K.C, Mahdi, S.S. (1986) Biogas Technology – A Practical Handbook, Tata McGraw Hill
5. Mahaeswari, R.C. (1997) Bio Energy for Rural Energisation, Concepts Publication.

	Mar Athanasius College **Kothamangalam**

Programme	**BSc Physics (Honours)**					
Course Name	**Advanced Classical Mechanics**					
Type of Course	**DCE**					
Course Code	M24PH7DCE403					
Course Level	**400**					
Course Summary	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 Special theory of relativity					
Semester	5	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practicum	Others	
		60	**0**	**0**		**60**
Pre-requisites, if any	Basic ideas of Newtonian Mechanics					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PSO No
1	To Describe the evolution of Classical Mechanics as a discipline of science.	A, An	1, 2
2	To Understand the basic concepts of Lagrangian formulation	U, A	1, 2
3	To make use of the central force problem in different dynamical system	U, An, A	1, 2
4	Understand the physics of small oscillations and concepts of canonical transformations and Poisson brackets	U, A, An	1, 2
5	Understand Hamilton-Jacobi method and the concept of action-angle variables.	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 and Hamiltonian formulation**		**15**	
	1.1	D' Alembert's principle and Lagrange's equations; velocity-Dependent potentials and the Dissipation Function;	4	1
	1.2	Lagrangian for a charged particle in electromagnetic field; - Application of Lagrange's equation to: motion of a single particle in Cartesian coordinate system and plane polar coordinate system; bead sliding on a rotating wire.	4	1, 2
	1.3	Hamilton's Principle; Technique of Calculus of variations; The Brachistochrone problem. - Derivation of Lagrange's equations from Hamilton's Principle. - Canonical momentum; cyclic coordinates;	4	1, 2
	1.4	Conservation laws and Symmetry properties-homogeneity of space and conservation of linear momentum; isotropy of space and conservation of angular momentum;	4	1, 2
	1.3	Homogeneity of time and conservation of energy - Noether's theorem (statement only; no proof is expected). Hamilton's canonical equations of motion; Hamiltonian for a charged particle in an electromagnetic field.	3	1, 2
2	**Two body central force problem**		**15**	
	2.1	Reduction of two-body problem to one-body problem	2	3
	2.2	Equation of motion for conservative central forces - angular momentum and energy as first integrals; law of equal areas - Equivalent one-dimensional problem – centrifugal potential; classification of orbits.	4	3
	2.3	Differential Equations for the orbit; equation of the orbit using the energy method; The Kepler Problem of the inverse square law force;	3	3
	2.4	Scattering in a central force field - Scattering in a Coulomb field and Rutherford scattering cross section.	3	3
	2.5	Independent coordinates of a rigid body; Orthogonal transformations; Euler Angles - Infinitesimal rotations: polar and axial vectors-Euler equations of motion - force free motion of a symmetrical top.	3	3

3	**Small oscillations**		**15**	
	3.1	Stable equilibrium unstable equilibrium and neutral equilibrium; motion of a system near stable equilibrium- Lagrangian of the system and equations of motion - Small oscillations- frequencies of free vibrations	4	4
	3.2	Normal coordinates and normal modes - system of two coupled pendula-resonant frequencies normal modes and normal coordinates;free vibrations of CO2 molecule- resonant frequencies normal modes and normal coordinates.	3	4
	3.3	Equations of canonical transformations; Four basic types of generating functions and the corresponding basic canonical transformations. Examples of canonical transformations - identity transformation and point transformation. - Solution of harmonic oscillator using canonical transformations	4	4
	3.4	Poisson Brackets ; Fundamental Poisson Brackets; Properties of Poisson Brackets - Equations of motion in Poisson Bracket form; Poisson Bracket and integrals of motion; Poisson's theorem; Canonical invariance of the Poisson bracket.	4	4
4	**Hamilton-Jacobi theory and action-angle variables**		**15**	
	4.1	Hamilton-Jacobi Equation for Hamilton's Principal Function - physical significance of the principal function- Harmonic oscillator problem using the Hamilton-Jacobi method - Hamilton-Jacobi Equation for Hamilton's characteristic function -	6	5
	4.2	Separation of variables in the Hamilton-Jacobi Equation - Separability of a cyclic coordinate in Hamilton-Jacobi equation	4	5
	4.3	Hamilton-Jacobi equation for a particle moving in a central force field(plane polar coordinates) - Action-Angle variables - harmonic oscillator problem in action-angle variables.	5	5
5		Teacher Specific Content	To be evaluated internally	

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecturing, Problem Solving
Assessment Types	MODE OF ASSESSMENT A**. Continuous Comprehensive Assessment (CCA)** Theory Total = 30 marks Quiz, Test Papers, seminar
	B**. End Semester Examination** Theory Total = 70 marks, Duration 2 hrs Part A (Short answer) – 10 out of 12 x 2 = 20 marks Part B (Short essay) – 6 out of 9 x 5 = 30 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks

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.

	Mar Athanasius College **Kothamangalam**

Programme	**BSc Physics (Honours)**					
Course Name	**Research and Professional Ethics**					
Type of Course	DCE					
Course Code	M24PH7DCE405					
Course Level	**400**					
Course Summary	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					
Semester	7	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		60	0	0	0	60
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PSO No
1	To introduce the literature Survey and methodology of Research especially in data collection and analysis in Science	K	2
2	To create an authentic scientific paper for Journal or Seminar from the result of analysis	An,C	1.3,4
3	To prepare a project proposal in the proper format	A,C	4,5
4	To practice the research ethics in our area of research	A	4,5
5	To make use of Computer and internet tools in the research	A	5
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 Teritary – 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 Analysis using statistical package ,Hypothesis ,testing ,Generalization and Interpretation ,Modelling.	7	2
3	**Scientific Writing**		**17**	
	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 foot notes ,	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
	Research Ethics and Application of Computer in Research		**15**	
4	4.1	Ethical Issues ,Ethical Committees ,Commercialization ,copy right ,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	
	4.3	MS office and its application in Research – MS Word, MS Power point and MS Excel	5	6
	4.4	Use of 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 Total = 30 marks Quiz, Test Papers, seminar
	B**. End Semester Examination** Theory Total = 70 marks, Duration 2 hrs Part A (Short answer) – 10 out of 12 x 2 = 20 marks Part B (Short essay) – 6 out of 9 x 5 = 30 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks

Text Books

1. Kothari, C. R. "Research Methodology: Methods and Techniques2004." (2004).
2. K.Prathapan, Research Methodology for Scientific Research, I.K International Publishing House Pvt. Ltd. (2014).
3. Alexander Bird,. (2006). Philosophy of Science. Routledge.ISBN 9781857285048
4. Indian National Science Academy. 2019. Ethics in Science Education, Research and Governance.Edited by K Muralidhar Amit Ghosh AK Singhvi ISBN: 978-81-939482-1-7
5. Chaddah, P. (2018) Ethics in Competitive Research: Do not get scooped; do not get plagiarized. ISBN 9387480860
6. Israel, M. (2015). Research Ethics and Integrity for Social Scientists: Beyond Regulatory Compliance. (Second ed.) SAGE Publications Ltd.

Reference

1. Research Methods Design, and Analysis, Larry B. Christensen, R. Burke Johnson, Lisa A Turner, Eleventh edition, Pearson (2015).
2. Research Methodology, Ranjit Kumar, Sage Publications (2012).
3. Fundamentals of Research Methodology and statistics: Yogesh Kumar Singh, New Age international Publications
4. Ethics in science education, research and governance: Edited by Kambadur Muralidhar, Amit Ghosh, Ashok Kumar Singhvi, Indian National Science Academy

	Mar Athanasius College Kothamangalam

Programme	**BSc Physics (Honours)**					
Course Name	**General Relativity and Applications**					
Type of Course	**DCE**					
Course Code	M24PH7DCE406					
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	
		60		0		60
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PSO 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	3,4
3	Analyze physical situations involving gravity	U An	3,4 ,5
4	To enable the pursuit of answers to open questions	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	**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	To be evaluated internally	

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 Total = 30 marks Quiz, Test Papers, seminar
	B**. End Semester Examination** Theory Total = 70 marks, Duration 2 hrs Part A (Short answer) – 10 out of 12 x 2 = 20 marks Part B (Short essay) – 6 out of 9 x 5 = 30 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks

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

Course Code	Title of the Course	Type of the Course	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
M24PH8DCC400	Advanced Quantum Mechanics	DCC	4	5	3	0	2	0
M24PH8DCC401	Condensed Matter Physics	DCC	4	5	3	0	2	0
M24PH8DCE400	Advanced Nuclear and Particle Physics	DCE	4	5	3	0	2	0
M24PH8DCE401	Electronics							
M24PH8DCE402	Microelectonics and Semiconductor Devices							
M24PH8DCE403	Communication Systems							
M24PH8PRJ400	Project* (UG Degree-Honours)		8					
M24PH8PRJ401	Project*(UG Degree - Honours with Research)		12					

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

	Mar Athanasius College **Kothamangalam**

Programme	BSc Physics (Honours)					
Course Name	Advanced Quantum Mechanics					
Type of Course	DCC					
Course Code	To be prepared by the University					
Course Level	400					
Course Summary	At the advanced level, this course in quantum mechanics invites the student to experience the thrill of learning the counterintuitive ways of the quantum world. Basic machinery of quantum mechanics is introduced with three-dimensional examples. Exact and approximate methods to study time independent interactions, techniques to analyze scattering and perturbative approaches to time-dependent interactions are dealt with.					
Semester	8	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practicum	Others	
		45	0	30	0	75
Pre-requisites, if any	Basic knowledge of Quantum Mechanics					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PSO 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 $\psi(x)=cexp(-\alpha x2)$, 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 $\psi(x)=Cexp(-\alpha\|x\|)$, treating α as a variational parameter.	8	2,3,5
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 $\square(\square) = \frac{-\square^2}{4\square\epsilon_0}\frac{\square^{-\square\,\square}}{\square}$ 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)** Lecturing, Problem Solving.
Assessment Types	**MODE OF ASSESSMENT** A**. Continuous Comprehensive Assessment (CCA)** Theory Total = 25 marks Quiz, Test Papers, seminar

	B. End Semester Examination Theory Total = 50 marks, Duration 1.5 hrs Part A (Short answer) – 10 out of 12 x1 =10 marks Part B (Short essay) – 4 out of 6 x 5 = 20 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks

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.

	Mar Athanasius College **Kothamangalam**

Programme	**BSc Physics (Honours)**					
Course Name	**Condensed Matter Physics**					
Type of Course	DCC					
Course Code	M24PH8DCC401					
Course Level	**400**					
Course Summary	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.					
Semester	8	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		45		30		75
Pre-requisites if any	Proficiency in topics like quantum mechanics and statistical mechanics beyond introductory levels and thermodynamics may be beneficial.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Acquire a comprehensive understanding of fundamental principles in Wave Diffraction, Free Electron Fermi Gas, demonstrating the ability to explain the underlying concepts and theories.	U, A, An	1, 4
2	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	Apply knowledge of superconductivity to analyze and solve problems related to superconducting materials, demonstrating proficiency in predicting superconducting behaviors under varying conditions and 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
4	Critically analyze advanced concepts in the magnetic properties of solids, such as magnetic domains, magnetic anisotropy, and the influence of crystal structure on	U, A, An	1, 2

	magnetic behavior.		
5	Experiential applied learning by simulation and visualization using MATLAB	U, 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	**Wave Diffraction, Reciprocal Lattice, Crystal Symmetry, and Free Electron Fermi Gas, Superconductivity**		**16**	
	1.1	Diffraction of waves by crystals – Bragg's Law – Scattered wave amplitude – reciprocal lattice vectors – diffraction condition – Laue equations – Ewald construction	2	1
	1.3	Diffraction intensity – structure factor and atomic form factor – physical significance	3	1
	1.5	Free electron gas in three dimensions – Heat capacity of the electron gas – relaxation time and mean free path	2	2
	1.6	Electrical conductivity and Ohm's law – Wiedemann-Franz Lorenz Law – electrical resistivity of metals	3	2
	1.7	Superconductivity – effect of magnetic field – Meissner effect – Type I and type II superconductors - Isotope effect – entropy – heat capacity – Energy gap – Cooper pairs and elements of BCS theory - Josephson effects	6	5
2	**Crystal Vibrations and Thermal Properties**		**12**	
	2.1	Vibrations of crystals with monatomic basis – First Brillouin zone – Group and Phase Velocity – Two atoms per Primitive Basis (1D)	5	3,4
	2.2	Quantization of elastic waves – Phonon momentum – Inelastic scattering of phonons; Anharmonic Crystal interactions – Thermal Expansion	2	
	2.3	Phonon Heat Capacity – Einstein Model – Debye model – Debye T^3 Law; Thermal Conductivity	5	
3	**Optical & Magnetic Properties of Solids**		**17**	
	3.1	Plasmon – Polaritons, Electron-Electron Interaction – Electron - Phonon Interaction: Polarons, Optical Processes – Optical reflectance – Kramers-Kronig Relations	7	5
	3.2	Quantum theory of paramagnetism – Hunds rules – crystal field splitting – spectroscopic splitting factor,	5	4, 5

		Cooling by adiabatic demagnetization – Nuclear Demagnetization		
	3.3	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	5	
4		**Lab Content (Condensed Matter Physics with MATLAB)**	30	5
	4.1	visualize a plane whose intercepts are provided and shows their relatiosnship to the Miller indices		
	4.2	Draw the Brillouin zone for the simple cubic and its irreducible tetrahedron and calculate the volume		
	4.3	simulation of the distance between two particles in 1 d using the Lennard-Jones potential		
	4.4	Calculate potential of ionic NaCl system		
	4.5	Simulation of the time dependent motion of N+1 particle Phonons: One Atom Per Primitive Cell oscillator chain model		
	4.6	Calculate the phonon internal energy for a Copper crystal based on the Debye Model.		
	4.7	Illustration of the classical transverse and logitudinal resistivities along with their quantum mechanical versions		
	4.8	Solve for the energy eigenvalues versus k’ in the Kronig-Penney model of a one dimensional crystal		
	4.9	Use the charge neutrality condition to obtain the chemical potential (mu) self-consistently based on the donor (ND) and acceptor (NA) concentration.		
	4.10	Tight binding model band for the simple cubic system		
	4.11	Simple cubic’s first Brillouin zone superimposed onto the Fermi surface		
	4.12	Display the magnetic anisotropy energy surface of an isotropic cubic crystal in (i) the absence and (ii) the presence of a magnetic field using the expression for cubic magnetic anisotropy energy		
	4.13	Radial hydrogenic wavefunctions and radial distribution function for n = 3 orbitals		

	4.14	Plots the Brillouin function for different values of the total angular momentum J.	
	4.15	Plot the reflectance from a metal below, at, and above the plasma frequency using the Drude free electron theory for a weakly damped system.	
	4.16	Plot the real and imaginary parts of the susceptibility derived within the Drude-Lorentz theory	
5		Teacher Specific Content	To be evaluated internally

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 Total = 25 marks Quiz, Test Papers, seminar Practical Total = 15 marks Lab performance, record, field report etc.
	B. End Semester Examination Theory Total = 50 marks, Duration 1.5 hrs Part A (Short answer) – 10 out of 12 x1 =10 marks Part B (Short essay) – 4 out of 6 x 5 = 20 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks Practical Total = 35 marks; Duration- 2 hrs Record 10 marks, Examination 25 marks

Textbook

1. Puri, R. K., Babbar, V. K. Solid State Physics, S. Chand Publishing 2010.
2. Wahab, M. A. (2008). Solid State Physics. Narosa Publishing House.
3. Kittel, C., Introduction to Solid State Physics, Wiley India Pvt. Ltd. 8th Edition, 2004.
4. Introductory Solid State Physics with MATLAB Applications, J. E Hasbun and T. Datta, CRC Press, 2020

References

1. Pillai, S.O., Solid State Physics, New Age International Private Limited 10th Edition 2022.
2. Elements of Solid State Physics, J P Srivastava, PHI Learning, 2015
3. Ashcroft, N. W. and Mermin, N. D. Solid State Physics, Cengage Learning 1st Edition, 2003.
4. Ali Omar, M. Elementary Solid State Physics Principles and Applications, Pearson India, 1st Edition 2001

	Mar Athanasius College Kothamangalam

Programme	**Physics**					
Course Name	**Advanced Nuclear and Particle Physics**					
Type of Course	**MAJOR (DSE)**					
Course Code	**To be prepared by the College**					
Course Level	**400**					
Course Summary	This course aims to provide the student to build up the fundamentals of nuclear and particle physics. After undergoing this course, the student will have knowledge about (1) the basic properties of the nucleus and the nuclear forces. (2) Major models of the nucleus and the theory behind the nuclear decay process;(3) the physics of nuclear reactions (4) the interaction between elementary particles and the conservation laws in particle physics.					
Semester	8	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practicum	Others	
		45	**0**	**30**		**75**
Pre-requisites, if any	Nuclear Physics Fundamentals					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PSO No
1	To get an idea about the fundamentals of nuclear physics	U	1
2	Understand the basic properties of nucleus and the nuclear forces	U	1
3	Understand the Major nuclear models	U, An	1, 2, 3

4	Understand the theory behind the nuclear decay	U	1
5	Understand the interaction between the elementary particles and the conservation laws in nuclear physics	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	**Nuclear Properties and Force between Nucleons**		**19**	
	1.1	The nuclear radius- distribution of nuclear charge (isotope shift, muonic shift, mirror nuclei); distribution of nuclear matter.	4	1,2
	1.2	Mass and abundance of nuclides, nuclear binding energy - Nuclear angular momentum and parity	3	1, 2
	1.3	Nuclear electromagnetic moments- quadrupole moment - The deuteron-binding energy, spin, parity, magnetic moment and electric quadrupole moment - Nucleon-nucleon scattering; Properties of nuclear forces.	4	1,2
	1.4	Practicum (Problems)	8	1,2
2	**Nuclear Models**		**18**	
	2.1	Liquid drop model, Bethe–Weizsacker formula, Applications of semi- empirical binding energy formula	4	3
	2.2	Shell Model-Shell model potential, Spin-orbit potential,	3	3
	2.3	Magnetic dipole moments, Electric quadrupole moments, Valence Nucleons - Collective structure-Nuclear vibrations, Nuclear rotations (qualitative idea only)	4	3

	2.7	Practicum (Problems)	7	3
3	**Nuclear Decay**		**18**	
4	3.1	Beta decay- energy release in beta decay; Fermi theory of beta decay	4	4
	3.2	Angular momentum and parity selection rules- allowed and forbidden transitions.	3	4
	3.3	Comparative half lives and forbidden decays; nonconservation of parity in beta decay	3	4
	3.5	Practicum (Problems)	8	4
4	**Particle Physics**		**20**	
	4.1	Yukawa's hypothesis; properties of pi mesons- electric charge, isospin, mass, spin and parity.	2	5
	4.2	Types of interactions between elementary particles,	2	5
	4.3	Hadrons and leptons - Symmetries and conservation laws, C P and CPT invariance	2	5
	4.4	Quark model, confined quarks, coloured quarks and gluons	2	5
	4.5	Experimental evidence for quark model, quark-gluon interaction,	2	5
	4.6	Grand unified theories; standard model of particle physics; qualitative ideas of Higg's boson and the LHC experiments.	3	5
	4.7	Practicum (Problems)	7	5

5		Teacher Specific Content	To be evaluated internally	

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecturing, Practicum sessions
Assessment Types	**MODE OF ASSESSMENT** A**. Continuous Comprehensive Assessment (CCA)** Theory Total = 25 marks Quiz, Test Papers, seminar
	B. End Semester Examination Theory Total = 50 marks, Duration 1.5 hrs Part A (Short answer) – 10 out of 12 x1 =10 marks Part B (Short essay) – 4 out of 6 x 5 = 20 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks

Textbook

1. Introductory Nuclear Physics, K. S. Krane JohnWiley
2. Nuclear Physics: Problem-based Approach Including MATLAB, Hari M Agarwal, PHI Learning Private Limited, Delhi.
3. Nuclear Physics, S.N. Ghoshal, S. Chand &Company

References

1. Problems and Solutions in Atomic, Nuclear and Particle Physics: Yung-Kuo Lim, WorldScientific.
2. Nuclear Physics, S.N. Ghoshal, S. Chand &Company.
3. Introduction to Nuclear and Particle Physics : V M Mittal , R C Verma, S C Gupta (Prentice Hall India.
4. Concepts of Nuclear Physics: B L Cohen, TataMcGrawHill
5. Nuclear Physics: An Introduction – S B Patel, New AgeInternational.
6. Nuclear Physics: R R Roy and B P Nigam, New AgeInternational.
7. Nuclear Physics: R Prasad,Pearson.
8. Atomic Nucleus: R D Evans, Mc GrawHill, NewYork.
9. Nuclear Physics: I Kaplan, Narosa, New Delhi(2/e)
10. Nuclear and Particle Physics, B R Martin, John Wiley & Sons, New York, 2006.
11. Introduction to Elementary Particles : David Griffith,Wlley-VCH.
12. https://nptel.ac.in/course/115104043/
13. https://www.ias.ac.in/article/fulltext/reso/022/03/0245-0255
14. https://www.ias.ac.in/article/fulltext/reso/017/10/0956-0973
15. https://atlas.cern/updates/atlas-feature/higgs-boson

	Mar Athanasius College **Kothamangalam**

Programme	**BSc Physics (Honours)**					
Course Name	**Electronics**					
Type of Course	DCE					
Course Code	M24PH8DCE401					
Course Level	**400**					
Course Summary	The Electronics course focuses on the principles and practical applications of operational amplifiers (op-amps) and linear integrated circuits. It provides students with a comprehensive understanding of op-amp circuits, their characteristics, and various linear integrated applications. Through theoretical study and hands-on laboratory exercises, students gain proficiency in designing, analyzing, and troubleshooting op-amp circuits for a wide range of electronic systems.					
Semester	8	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		45		30		75
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Analyze op-amp and its different configurations with their physical Operation	K, A	1, 2
2	Design and analyze different applications of op-amps	An	2
3	Evaluate frequency response to understand behavior of op-amps and electronics circuits using op-amps	An, S	3, 6
4	Demonstrate the ability to design practical circuits that perform the desired operations	U, E, S	3, 6
5	Analyze important types of integrated circuits.	U, An	3, 6
6	Acquire collaboration skills through team-based laboratory activities.	U, A, An, I, S	1, 5, 6
7	To design and construct linear integrated circuits	U, A, An, C	2, 3, 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	**The Practical Op-amp and General Linear Applications**		**15**	
1	1.1	Input offset voltage – Input bias current – input offset current – Total output offset voltage	3	1
	1.2	Common mode configuration and CMRR.	2	1
	1.3	DC and AC amplifiers – AC amplifier with single supply voltage - Peaking amplifier - Summing, Scaling, averaging amplifiers	2	1, 2,4
	1.4	Instrumentation amplifier using transducer bridge Differential input and differential output amplifier	3	1, 2, 4
	1.5	Low voltage DC and AC voltmeter - Voltage to current converter with grounded load	3	1, 2, 4
	1.6	integrator and differentiator.	2	1, 2, 4
2	**Frequency Response of an Op-amp, Active Filters and Oscillators**		**15**	
2	2.1	Frequency response – Compensating networks – Frequency response of internally compensated and non-compensated op-amps	2	3
	2.2	High frequency op- amp equivalent circuit - Open loop gain as a function of frequency Closed loop frequency response - slew rate	3	3
	2.3	Active filters – First order and second order low pass Butterworth filter - First order and second order high pass Butterworth filter	3	1, 2, 3, 4
	2.4	Wide and narrow band pass filter - wide and narrow band reject filter-All pass filter	3	1, 2, 3, 4
	2.5	Oscillators: Phase shift and Wien-bridge oscillators	2	3, 4
	2.6	Square and triangular wave generators	2	2, 4
3	**Comparators and Converters**		**15**	
3	3.1	Basic comparator - Zero crossing detector - Schmitt Trigger – Comparator characteristics - Limitations of op-amp as comparators	4	2, 4

	3.2	Voltage to frequency and frequency to voltage converters	3	2, 4
	3.3	D/A and A/D converters	2	5
	3.4	Peak detector - Sample and Hold circuit.	2	5
	3.6	IC555 Internal architecture - Applications IC565 – PLL - Voltage regulator ICs 78XX and 79XX	4	5
4	**Lab Content**		30	6, 7
	4.1	Op-Amp parameters (i) Open loop gain (ii) input offset voltage (iii) input bias current (iv)) CMRR (v) slew rate (vi) Band width		
	4.2	Design and construct an integrator using Op-Amp (*μA741)*, draw the input output curve and study the frequency response.		
	4.3	Design and construct a differentiator using Op-Amp (*μA741) for sin wave and square wave input* and study the output wave for different frequencies.		
	4.4	Design and construct a square wave generator using Op-Amp (*μA741) for a frequency f0*.		
	4.5	Design and construct a triangular wave generator using (*μA741) for a frequency f0*.		
	4.6	Design and construct a saw tooth wave generator using Op-Amp (*μA741)* generator.		
	4.7	Design and construct an Op-Amp Wien bridge oscillator with amplitude stabilization and study the output wave form		
	4.8	Design and construct a Schmidt trigger using Op-Amp μA741, *plot of the hysteresis curve.*		
	4.9	Design and construct an astable multivibrator using *μA741 with duty cycle other than 50%*		
	4.10	Design and test a RC phase shift oscillator using transistor for a given operating frequency.		
	4.11	Study the application of op-Amp (*μA741) as a d*ifferential amplifier.		
	4.12	Design and construct a RC phase shift oscillator using *μA741for a frequency f0.*		
	4.13	Design and construct a first and second order low pass Butterworth filter using *μA741 and plot the frequency response curve.*		

	4.14	Design and construct a first and second order high pass Butterworth filter using *μA741 and study the frequency response.*		
	4.15	Design and construct a first order narrow band pass Butterworth filter using *μA741.*		
	4.16	Design and construct ccurrent to voltage and voltage to current converter (*μA741*)		
	4.17	Astablemultivibrator using 555 timer, study the positive and negative pulse width and free running frequency.		
	4.18	Monostablemultivibrator using 555 timers and study the input output waveform.		
	4.19	Voltage controlled Oscillator using 555 timer		
	4.20	Design and construct a Schmitt Trigger circuit using IC 555.		
	4.21	Design and test a two stage RC coupled common emitter transistor amplifier and find th bandwidth, mid-frequency gain, input and output impedance.		
5		Teacher specific content	To be evaluated internally	

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, Tutorial, Demonstration
Assessment Types	**MODE OF ASSESSMENT** A**. Continuous Comprehensive Assessment (CCA)** Theory Total = 25 marks Quiz, Test Papers, seminar Practical Total = 15 marks Lab performance, record, field report etc.
	B. End Semester Examination Theory Total = 50 marks, Duration 1.5 hrs Part A (Short answer) – 10 out of 12 x1 =10 marks Part B (Short essay) – 4 out of 6 x 5 = 20 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks Practical Total = 35 marks; Duration- 2 hrs Record 10 marks, Examination 25 marks

Text Books:

1. Op-amps and linear integrated circuits R.A. Gayakwad 4thEdn.PHI
2. Electronic Communication Systems, Kennedy& Davis 4thEd.TMH,

References:

1. Electronic Devices (Electron Flow Version), 9/E Thomas L. Floyd, Pearson
2. Fundamentals of Electronic Devices and Circuits 5th Ed. David A. Bell, Cambridge.

References for Lab Activities:

1. Op-Amp and linear integrated circuit, Ramakanth A Gaykwad, Eastern Economy Edition, ISBN-81-203-0807-7
2. Electronic Laboratory Primer a design approach, S. Poornachandra, B.Sasikala, Wheeler Publishing, New Delhi
3. Electronic lab manual Vol I, K A Navas, Rajath Publishing
4. Electronic lab manual Vol II, K A Navas, PHI eastern Economy Edition
5. Electronic lab manual Vol II, Kuriachan T.D, Syam Mohan, Ayodhya Publishing
6. An advanced course in Practical Physics, D.Chattopadhayay, C.R Rakshit, New Central Book Agency Pvt. Ltd:

	Mar Athanasius College **Kothamangalam**

Programme	**BSc Physics (Honours)**					
Course Name	**Microelectronics and Semiconductor Devices**					
Type of Course	**DCE**					
Course Code	**M24PH8DCE402**					
Course Level	**400**					
Course Summary	This course will explain the architecture and instruction set of 8085 microprocessor. This course also covers fundamentals of semiconductor devices and their processing steps in detail. The student will be able to use the knowledge of semiconductor fabrication processes to work in industry in the area of semiconductor devices.					
Semester	8	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		45	0	30	0	75
Pre-requisites, if any	Fundamentals of Digital Logic Design and Computer Organization					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PSO No
1	Understand the architecture and instruction set of basic microprocessors	U	1,2
2	Analyse and solve simple programs using 8085 microprocessor machine language	U, A, An	1,2
3	Analyse the fundamentals of semiconductor devices and their processing steps	U,A, An	1,2
4	Apply the knowledge of semiconductor fabrication process used in industry in the area of semiconductor devices	U, A	1,2, 3
5	Hands on training to write and execute problems using 8085 assembly language	U, A	1,2, 5
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	**8085 Microprocessor**		**18**	
	1.1	Introduction to Microprocessor, Components of a Microprocessor: Registers, ALU and control & timing, System bus (data, address and control bus), Microprocessor systems with bus organization	**2**	**1**
	1.2	Microprocessor Architecture and Operations, Memory, I/O devices, Memory and I/O operations	**2**	**1**
	1.3	8085 Microprocessor Architecture, Address, Data And Control Buses, 8085 Pin Functions, Demultiplexing of Buses, Generation Of Control Signals, Instruction Cycle, Machine Cycles, T-States, Memory Interfacing	**3**	**1,2**
	1.4	Assembly Language Programming Basics, Classification of Instructions, Addressing Modes, 8085 Instruction Set, Instruction And Data Formats, Writing, Assembling & Executing A Program, Debugging The Programs	**3**	**1,2**
	1.5	Writing 8085 assembly language programs with decision, making and looping using data transfer, arithmetic, logical and branch instructions	**4**	**1,2**
	1.6	Stack & Subroutines, Developing Counters and Time Delay Routines, Code Conversion, BCD Arithmetic and 16-Bit Data operations	**2**	**1,2**
	1.7	Interfacing Concepts, Ports, Interfacing Of I/O Devices, Interrupts In 8085, Programmable Interrupt Controller 8259A, Programmable Peripheral Interface 8255A	**2**	**1,2**
2	**Metal-semiconductor and semiconductor hetero-junctions**		**13**	
	2.1	Metal-semiconductor - Schottky barrier diode - qualitative characteristics – ideal junction properties Current voltage relationship, Comparison with junction diode.	3	3
	2.2	Metal semiconductor ohmic contact - Ideal non rectifying barriers – tunneling barrier – specific contact resistances	4	3
	2.3	Semiconductor hetero-junctions – hetero- junction materials – energy band diagram	3	3
	2.4	Two dimensional electron gas - equilibrium electrostatics – current voltage characteristics.	3	3
3	**Integrated Circuit Fabrication and Characteristics**		**14**	

	3.1	Integrated circuit technology – basic monolithic IC – epitaxial growth –marking and etching - diffusion of impurities – transistor for monolithic circuit –	5	4
	3.2	Monolithic diodes – integrated resisters, capacitors and inductors-monolithic circuit layout	5	4
	3.3	Additional isolation methods -MSI, LSI, VLSI– the metal semiconductor contact.	5	4
4	**Practicals**: **Microprocessor (use a PC or 8085-µp kit)**		30	
	4.1	Write an 8085 assembly language program for exchanging two 8-bit numbers stored in memory locations 2050h and 2051h.		5
	4.2	Write an 8085 assembly language program to add two 8-bit numbers stored in memory locations 2050h and 2051h. Store result in location 2052h.		5
	4.3	Write an 8085 assembly language program to add two 16-bit numbers stored in memory.		5
	4.4	Write an 8085 assembly language program to add two decimal numbers using DAA instruction.		5
	4.5	Write an 8085 assembly language program to find the minimum from two 8-bit numbers.		5
	4.6	Write an 8085 assembly language program to add block of 8-bit numbers.		5
	4.7	Write an 8085 assembly language program to get the minimum from block of N 8-bit numbers.		5
	4.8	Write an 8085 assembly language program to find the number of 1's binary representation of given 8-bit number.		5
	4.9	Conversion of Hexadecimal number to ASCII and ASCII to Hexadecimal number		5
	4.10	Write an 8085 assembly language program to count the length of string ended with 0dh starting from location 2050h.		5
	4.11	Write an 8085 assembly language program to compute even parity and insert it as MSB in 8-bit number		5
	4.12	Write a subroutine to exchange two 8-bit numbers. Use it to reverse an array of 8-bit numbers.		5
		Teacher Specific Content	To be evaluated internally	

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecturing, Problem Solving, Practical
Assessment Types	**MODE OF ASSESSMENT** A**. Continuous Comprehensive Assessment (CCA)** Theory Total = 25 marks Quiz, Test Papers, seminar Practical Total = 15 marks Lab performance, record, field report etc.
	B. End Semester Examination Theory Total = 50 marks, Duration 1.5 hrs Part A (Short answer) – 10 out of 12 x1 =10 marks Part B (Short essay) – 4 out of 6 x 5 = 20 marks Part C (Long essay) – 2 out of 4 x 10 = 20 marks Practical Total = 35 marks; Duration- 2 hrs Record 10 marks, Examination 25 marks

Text Book:

1. Microprocessor Architecture, Programming, and Applications with the 8085, Ramesh S. Gaonkar Pub: Penram International.
2. Semiconductor Physics and Devices, Donald A. Neamen, McGraw Hill
3. Integrated Electronics-Analogue and Digital Circuits and Systems, J Millmann and C C Halkias, TMGH

Reference Books:

1. Microprocessors and Interfacing, N. Senthil Kumar, M. Saravanan, S. Jeevanathan, S. K. Shah, Oxford
2. Fundamentals of Microprocessors and microcomputers- B. Ram (DhanpatRaiPub.)
3. Solid state electronic devices, Streetman and Banerjee, PHI (2010).
4. Physics of Semiconductor Devices, Michael Shur, PHI (2002).
5. Introduction to Semiconductor materials and Devices, M.S. Tyagi, John Wiley and Sons (2000)

	Mar Athanasius College **Kothamangalam**

Programme	**BSc Physics (Honours)**					
Course Name	**Communication Systems**					
Type of Course	**DCE**					
Course Code	**M24PH8DCE403**					
Course Level	**400**					
Course Summary	This course will help to understand the basic concepts of different communication systems.					
Semester	8	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		45	0	30	0	75
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PSO No
1	Understanding the basic concepts of communication systems - digital, satellite and fiber optic communication systems.	U	1, 2
2	Describe the development and functioning of digital, satellite and fiber optic communication systems	U, An	1, 2, 3, 4
3	Understand different modulation and demodulation techniques used in analog and digital communication	U, A	1, 2, 3
4	Identify and compare different communication systems	U, An, E	1, 2
5	Get practical knowledge by conducting experiments on communication systems	U, A, An, S, Ap	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	**Digital Communication**		**15**	
1	1.1	Pulse Communication - Introduction - Pulse modulation – PAM - PWM – PPM	5	1, 2, 3
	1.2	PCM – Sampling theorem- Quantization - Generation and demodulation of PCM - Delta modulation	3	1, 2
	1.3	Information theory - Coding - Digital codes – Error detection and correction	2	1, 2
	1.4	Data sets and interconnection requirements - Modem classification and interfacings	2	2, 3
	1.5	– Multiplexing techniques - Frequency division multiplex - Time-division multiplexing - Digital transmission techniques - ASK - FSK - PSK	3	2, 3, 4
2	**Satellite Communication**		**15**	
	2.1	Satellite Communication Fundamentals - Satellite Orbits - Satellite Positioning - Frequency Allocations - Polarization - Antennas - gain-beam width -	5	1, 2
	2.2	Multiple Access Techniques - Geostationary Satellite communication-Satellite parameters - VSAT (Basic Idea)	5	1, 2, 4
	2.3	Geostationary Satellite Path/Link Budget - Satellite TV Systems- Satellite TV broadcasting - GPS	5	2, 3, 4
3	**Fundamentals of Fiber Optic Communication**		**15**	
	3.1	Introduction - Ray theory transmission - Total Internal Reflection-Acceptance Angle - Numerical aperture - Skew rays - Electromagnetic mode theory for optical propagation - Electromagnetic waves - Modes in a planar guide - Phase and group velocity	6	1
	3.2	Fiber Classification - cylindrical fiber - Step Index - Graded Index - Single mode fiber:- Cut off wave length - Group delay - Photonic crystal fibers:- Index guided micro structures - Photonic band gapfibers	5	1, 2

	3.3	Dispersion:- chromatic - intermodal - Non linear effects. Optical fiber connection (basic idea)	4	1, 2
4	**Lab Content : Communication Systems**		**30**	5
	4.1	Generation PAM and PWM		
	4.2	Frequency modulation and demodulation using IC –CD4046.		
	4.3	Multiplexer and demultiplexer using digital IC 7432.		
	4.4	Measurement of characteristic impedance and transmission line parameters of a coaxial cable		
	4.5	Radiation characteristics of a horn antenna.		
	4.6	Data transmission and reception through optical fiber link.		
5		Teacher Specific Content	To be evaluated internally	

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, Discussions, Seminars, Problem Solving, Practical
Assessment Types	**MODE OF ASSESSMENT** A**. Continuous Comprehensive Assessment (CCA)** Theory Total = 25 marks Quiz, Test Papers, seminar Practical Total = 15 marks Lab performance, record, field report etc.
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Text Book:

1. Electronic Communication Systems by Kennedy/Davis, Mc Graw Hill Publication, 4th edition
2. Telecommunication Transmission Systems by Robert G Winch, McGrawHill Publication,2nd edition
3. Optical fiber communications-Principles and Practice John M Senior, Pearson publications, 3rd edition,

Reference Books:

1. Optical Fiber Communications by Gerd Keiser
2. Satellite Communications by Dennis Roddy,Mc Graw Hill Publication,3rd edition.
3. Satellite communication by Dr.D.C Agarwal.
4. Electronics Communication Systems by Wayne Thomas, Pearson Publication, 5 th Edition.