SCOTT CHRISTIAN COLLEGE (AUTONOMOUS)
NAGERCOIL

THE TRUTH SHALL MAKE YOU FREE

(Estd. 1893)

CURRICULUM AND SYLLABUS

DEPARTMENT OF PHYSICS & RESEARCH CENTRE

(Approved by the Standing Committee of the Academic Councils held on 21.10.2023 & 13.01.2024)

POSTGRADUATE PROGRAMME

CBCS-SEMESTER SYSTEM

(For those who join from 2023 to 2026)

An evolution towards revolution …

Education is crucial for attaining full human potential, developing an unbiased and evenhanded society and promoting national and global development. The education sector in India is witnessing a sweeping wave of change. The very first policy for education, *National Policy on Education* (NPE-1968) was promulgated in 1968, with the National Policy on Education (NPE- 1986) following in 1986. The National Policy on Education (NPE- 1992) and the Programme of Action 1992 (POA-1992) refined and implemented the NPE-1986. The National Education Policy 2020 (NEP 2020) is a landmark document and an evolution towards revolution in the Indian educational sector. It presents the vision for greater access, equity, excellence, inclusion, multiple entry and exit and affordability to help India emerge as the global knowledge superpower.

Providing access to quality education is the key to the curriculum and syllabus of Scott Christian College (Autonomous), in terms of social justice and equality, scientific advancement, cultural preservation and national and global integration. Students should have the freedom and flexibility in choosing their courses, skills, and capacities to become moral, successful, innovative, adaptable, and productive human beings.

Higher education plays an important role in promoting human as well as societal wellbeing and in contributing towards sustainable livelihoods and economic development. The present Outcome-Based Education (OBE) curriculum and syllabus, provides valuable insights and recommendations on aspects of education that include moving towards multidisciplinary and holistic education, mastery and high-order learning and promotion of quality research.

The current curriculum has been designed based on NEP 2020, the National Credit Framework (NCrF), the National Higher Education Qualifications Framework (NHEQF) and Curriculum and Credit Framework for Undergraduate Programmes (CCFUP) which envisage that students must develop into good, thoughtful, well-rounded, creative individuals with a standard of achievement. The themed curriculum aims to support teachers and students in developing their understanding of the curriculum design and delivery process as per the requirement of the world of work.

Dr.Sidney Shirly
Dean of Arts
Scott Christian College
(Autonomous)
Nagercoil

Dr. V. Robin Perinba Smith
Dean of Science
Scott Christian College
(Autonomous)
Nagercoil

Dr. B. Shamina Ross
Dean of IT and Technical Education
Scott Christian College
(Autonomous)
Nagercoil

DEPARTMENT OF PHYSICS & RESEARCH CENTRE

Physics is one of the basic and fundamental sciences. The curriculum for the under graduate and post graduate Programmes in Physics is revised as per the UGC guidelines on Learning Outcome based Course Framework. The learner-centric courses let the student progressively develop a deeper understanding of various aspects of Physics.

The new curriculum offers courses in the core areas and it will train students with sound theoretical and experimental knowledge that suits the need of academics and industry. In addition to the theoretical course work, the students also learn physics laboratory methods for different branches of physics, specialized measurement techniques, analysis of observational data, including error estimation and etc. The students will have deeper understanding of laws of nature through the subjects like classical mechanics, quantum mechanics, statistical physics etc. The problem-solving ability of students will be enhanced. The students can apply principles in physics to real life problems. The restructured courses with well-defined objectives and learning outcomes provide guidance to prospective students in choosing the elective courses to broaden their skills not only in the field of physics but also in interdisciplinary areas. The elective modules of the framework offer students choice to gain knowledge and expertise in specialized domains of physics like astrophysics, medical physics, etc.

The learner centric courses are designed to enable the students to progressively develop a good understanding of the concepts of various domains in physics. Significant modification is the inclusion of the courses to equip students to face challenges in industries and make them employable. Skill development in different spheres and confidence building are given a special focus.

VISION:

- ❖ Reform, transform and empower the young minds by imparting quality education.
- ❖ Upbringing the overall personalities of the students by providing state of the art learning experience.
- ❖ Inculcate universal brotherliness and tolerance with highest standard of integrity

MISSION:

- ❖ Reaching out to the unreached by providing equal opportunity to learn irrespective of the caste and creed.
- ❖ Create social interaction, environmental sustainability, economic progress, and scientific awareness through varied curriculum.
- ❖ Provide transferable skills, life skills, e-skills and soft-skills through diverse learning experience.
- ❖ Promote experimental learning, field-trips and internships to foster entrepreneurship and self-reliance.
- ❖ Foster critical thinking and effective communication by advance teaching and learning process.

ELIGIBILITY:

For M.Sc. - Candidates must have completed a bachelor's degree in Physics or any related field from a recognised university with a minimum score of 50%.

DURATION OF THE PROGRAMME:

2 Years (IV Semesters) for M.Sc. Physics

MEDIUM:

English for both B.Sc. & M.Sc. Degree Programmes in Physics

FACULTY MEMBERS

Sl. No.	NAME	DESIGNATION
1.	**Prof. A. CHARLES HEPZY ROY**	Faculty Head i/c Associate Professor
2.	**Dr. C. JAMES**	Associate Professor
3.	**Dr. C. BESKY JOB**	Associate Professor
4.	**Dr. Y. PREMILA RACHELIN**	Associate Professor
5.	**Dr. J.V. BYNAJA**	Associate Professor
6.	**Dr. V. ANSLIN FERBY**	Associate Professor
7.	**Dr. B.S. BENILA**	Associate Professor
8.	**Dr. Y. SHEEBA SHERLIN**	Associate Professor
9.	**Dr. T. R. BEENA**	Assistant Professor
10.	**Dr. S. SHARMILA JULIET**	Assistant Professor
11.	**Dr. D.J. JEEJAMOL**	Assistant Professor
12.	**Dr. H. ADLINE MAHIBA**	Assistant Professor
13.	**Dr. D. HUDSON OLIVER**	Assistant Professor

MEMBERS OF THE BOARD OF STUDIES

Sl. No.	NAME	AFFILIATION	ROLE
1.	**Prof. A. Charles Hepzy Roy**	Faculty Head i/c Department of Physics & Research Centre Scott Christian College (Autonomous), Nagercoil. charleshepzyroy@scottchristian.org +91 9944261881	**Chairman**
2.	**Dr. C. James**	Associate Professor of Physics Department of Physics & Research Centre Scott Christian College (Autonomous) Nagercoil. james@scottchristian.org +919489500237	**Member**
3.	**Dr. C. Besky Job**	Associate Professor of Physics Department of Physics & Research Centre Scott Christian College (Autonomous) Nagercoil. cbjob1969@gmail.com +919487026024	**Member**
4.	**Dr. Y. Premila Rachelin**	Associate Professor of Physics Department of Physics & Research Centre Scott Christian College (Autonomous) Nagercoil. premilarachelin@scottchristian.org +919489620591	**Member**
5.	**Dr. J.V. Bynaja**	Associate Professor of Physics Department of Physics & Research Centre Scott Christian College (Autonomous) Nagercoil. bynaja@scottchristian.org +919443284135	**Member**
6.	**Dr. V. Anslin Ferby**	Associate Professor of Physics Department of Physics & Research Centre Scott Christian College (Autonomous) Nagercoil. anslinferby@scottchristian.org +919443595694	**Member**
7.	**Dr. B.S. Benila**	Associate Professor of Physics Department of Physics & Research Centre Scott Christian College (Autonomous) Nagercoil. benila@scottchristian.org +919843626563	**Member**
8.	**Dr. Y. Sheeba Sherlin**	Associate Professor of Physics Department of Physics & Research Centre Scott Christian College (Autonomous) Nagercoil. sheebasherlin@scottchristian.org +919442304397	**Member**
9.	**Dr. T. R. Beena**	Assistant Professor of Physics Department of Physics & Research Centre Scott Christian College (Autonomous) Nagercoil. beena@scottchristian.org +919487386199	**Member**

10.	**Dr. S. Sharmila Juliet**	Assistant Professor of Physics Department of Physics & Research Centre Scott Christian College (Autonomous) Nagercoil. sharmilajuliet@scottchristian.org +919487094860	**Member**
11.	**Dr. D.J. Jeejamol**	Assistant Professor of Physics Department of Physics & Research Centre Scott Christian College (Autonomous) Nagercoil. jeejamol@scottchristian.org +917598629087	**Member**
12.	**Dr. H. Adline Mahiba**	Assistant Professor of Physics Department of Physics & Research Centre Scott Christian College (Autonomous) Nagercoil. adline@scottchristian.org +919408657877	**Member**
13.	**Dr. D. Hudson Oliver**	Assistant Professor of Physics Department of Physics & Research Centre Scott Christian College (Autonomous) Nagercoil., +919952654515 hudsonoliver@scottchristian.org	**Member**
14.	**Dr. C. Ravidhas**	Faculty Head PG & Research Department of Physics Bishop Heber College (Autonomous) Thiruchirapalli – 620 017 cravidhas@gmail.com +919443076209	**Subject Expert**
15.	**Dr. I. Hubert Joe**	Associate Professor Department of Physics University of Kerala Thiruvananthapuram – 695 034 hubertjoe@gmail.com +919447220563	**Subject Expert**
16.	**Dr. R. Sheela Christy**	Professor and Head, Department of Physics & Research Centre, Nesamony Memorial Christian College, Marthandam - 629165 sheelachristy64@yahoo.com +91 9442382469	**Vice-Chancellor's Nominee**
17.	**Mr. D. Gilbert Chandra**	Group Head, Instrumentation, ISRO Propulsion Complex, Mahendragiri– 627 133 gilbertd26@gmail.com +919442180572	**Representative**
18.	**Dr. V. Shally**	Assistant Professor, Department of Physics & Research Centre, Holy Cross College (Autonomous), Kurusady, Nagercoil – 629 002., shally.v@holycrossngl.edu.in +917598854466	**Post Graduate Meritorious Alumnus**

The Scott Christian College (Autonomous) defines the focus reinforcing its academic Programmes and student life experience on campus through the Graduate Attributes (GA), that describe the knowledge, competencies, values and skills students imbibe for holistic development, multidisciplinary development and contribution to society. These attributes comprise characteristics that are transferable beyond the sphere of study into the national and international realm through curricular, co-curricular and extra-curricular engagements. They equip graduates for life long personal development and employment. Every Graduate of Scott Christian College (Autonomous) – (SCC) is desired to possess the following Graduate Attributes:

GA 1: Intellectual Competencies

Graduates of SCC

- have a comprehensive and incisive understanding of their domain of study as well as the ability for cross-disciplinary learning
- have the ability to apply the knowledge acquired through the curriculum as well as self-directed learning to a broad spectrum ranging from analytical thinking to synthesize new knowledge through research
- are able to have critical, independent and individual outlook regarding academic work and socially relevant issues

GA 2: Problem Solving

Graduates of SCC

- have the capacity to extrapolate from what has been learnt, translate concepts to real-life situations and apply acquired competencies in the required contexts to generate solutions to specific problems
- can view a problem or a situation from multiple perspectives and think 'out of the box' and generate solutions to complex problems in unfamiliar contexts
- are effective problems-solvers, able to apply critical, creative and evidence-based thinking to conceive innovative responses to challenges

GA 3: Communication Skills

Graduates of SCC

- listen carefully, analyse texts and research papers, and present complex information in a clear and concise manner

- express thoughts and ideas effectively in writing and orally and communicate with others using appropriate media

- confidently express herself/himself and construct logical arguments using correct technical language related to a field of learning and area of professional practice

GA 4: Environmental Awareness

Graduates of SCC

- lessen the effects of environmental degradation, climate change, and pollution
- learn the nuances for cleanliness, conservation and wise use of resources so that it can be used for generations
- know the nuances of waste management, conservation of biological diversity, management of biological resources and biodiversity, and sustainable development and living

GA 5: Professional Ethics

Graduates of SCC

- develop principled and expert behaviour, and this will be showcased in their chosen careers and constructive roles as citizens of the world at large
- imbibe intellectual integrity and ethics in scholarly engagement and develop a spirit of inclusiveness through interactions with diverse people at all levels in life
- acquire new knowledge and skills, including ‘learning how to learn’ skills, for pursuing learning activities throughout life and adapting to

changing demands of the workplace through knowledge, skill development and reskilling, ethically

GA 6: Leadership Qualities

Graduates of SCC

- inculcate leadership qualities and attitudes, and team behaviour along autonomous lines through curricular, co-curricular and extra-curricular activities
- develop managerial and entrepreneurial skills to create new opportunities for diverse careers and gear up to take up competitive examinations
- act together as a group or a team in the interests of a common cause and workefficiently as a member of a team

GA 7: Holistic Skill Development

Graduates of SCC

- develop critical thinking, problem-solving capacity, effective communication, and social skills
- are self-aware, flexible, resilient and have the capacity to accept and give constructive feedback and cope up with stress
- develop soft skills, e-skills and life skills to live, learn and work in the technically sound society globally and use appropriate digital methods for analysis of data

GA 8: Cross-Cultural Competencies

Graduates of SCC

- gain cross-cultural competencies through engaging with diverse linguistic, ethnic and religious communities and know how to understand, accept and appreciate individuals at local, national and international levels
- develop a global perspective through contemporary curriculum, culture, language and international exchange programmes
- acquire knowledge of the values and beliefs of multiple cultures and a global perspective to honour diversity, gender sensitivity and adopt

gender-neutral approach and show empathy to the less advantaged and the differently-abled

GA 9: Community Engagement

Graduates of SCC

- are sensitive to social concerns and have conviction toward social justice through active social engagement
- are endowed with a strong sense of environmental awareness through the curriculum and a friendly and serene campus eco-system.
- formulate an inspiring vision and build a team that can help achieve the vision, and motivate people to the right destination

GA 10: Value-Based Ethical Competency

Graduates of SCC

- are rooted in the principles of ethical responsibility and integrity permeated with Christian values leading to the building of character and constitutional values
- develop virtues such as truth, love, courage, unity, integrity, brotherhood, industry and uprightness
- practice responsible national and global citizenship required for responding to contemporary challenges, enabling learners to become aware of and understand global issues and to become active promoters of more peaceful, tolerant, inclusive, secure, and sustainable societies

Learning Outcomes Descriptors for a Qualification at Level 6.5 on the NHEQF

The Master's degree is awarded to students who have demonstrated the achievement of the outcomes located at level 6.5 on the NHEQF.

ELEMENT OF THE DESCRIPTOR	NHEQF LEVEL DESCRIPTORS
Knowledge and Understanding	The graduates should be able to demonstrate the acquisition of: • advanced knowledge about a specialized field of enquiry with a critical understanding of the emerging developments and issues relating to one or more fields of learning • advanced knowledge and understanding of the research principles, methods, and techniques applicable to the chosen field of learning or professional practice, • procedural knowledge required for performing and accomplishing complex, specialized and professional tasks

	relating to teaching, and research and development.
General, Technical and Professional Skills	The graduates should be able to demonstrate the acquisition of: • advanced cognitive and technical skills required for performing and accomplishing complex tasks related to the chosen fields of learning. • advanced cognitive and technical skills required for evaluating research findings and designing and conducting relevant research that contributes to the generation of new knowledge. • specialized cognitive and technical skills relating to a body of knowledge and practice to analyse and synthesize complex information and problems.
Application of Knowledge and Skills	The graduates should be able to demonstrate the ability to: • apply the acquired advanced theoretical and/or technical knowledge about a specialized field of enquiry or professional practice and a range of cognitive and practical skills to identify and analyse problems and issues associated with the chosen fields of learning. • apply advanced knowledge relating to research methods to carry out research and investigations and to formulate evidence-based solutions to complex and unpredictable problems. • develop appropriate tools for data collection for research
Generic Learning Outcomes	The graduates should be able to demonstrate the ability to: • communicate in a well-structured manner, technical information and explanations, and the findings/results of the research studies undertaken in the chosen field of study, • evaluate the reliability and relevance of evidence; identify logical flaws and holes in the arguments of others; analyse and synthesize data from a variety of sources; draw valid conclusions and support them with evidence and examples, and address opposing viewpoints • pursue self-paced and self-directed learning to upgrade knowledge and skills, including research-related skills, required to pursue a higher level of education and research.
Constitutional, Humanistic, Ethical, and Moral Values	The graduates should be able to demonstrate the willingness and ability to: • embrace and practice constitutional, humanistic, ethical, and moral values in one's life and in the field of study and professional practice, • participate in actions to address environmental protection and sustainable development issues, • follow ethical principles and practices in all aspects of research and development, including inducements for enrolling participants and avoid unethical practices

Employability and Entrepreneurship Skills	The graduates should be able to demonstrate the acquisition of knowledge and skill sets required for: • adapting to the future of work and responding to the demands of the fast pace of technological developments and innovations that drive the shift in employers' demands for skills • transition towards more technology-assisted work involving the creation of new forms of work and rapidly changing work and production processes. • exercising full personal responsibility for the output of own work as well as for group outputs and for managing work that is complex and unpredictable requiring new strategic approaches.
Credit Requirements	• The 2-year/4-semester Master's programme builds on a 3-year/6-semester bachelor's degree and requires a total of a minimum of 80 credits from the first and second years of the programme, with a minimum of 40 credits in the first year and minimum of 40 credits in the second year of the programme at level 6.5 on the NHEQF.
Entry Requirements	• A 3-year Bachelor's degree for the 2-year/4-semester Master's degree programme (e.g. M.A., M.Com., M.Sc., etc.).

PLO & GA Mapping for M.Sc. Physics

PROGRAMME LEARNING OBJECTIVE #	PROGRAMME LEARNING OBJECTIVE (PLO)	DESCRIPTION OF PLO	PLO MAPPED WITH GA#
PLO 1	Learning Dispositions	Recognize and reflect on the production of knowledge in multiple spaces	GA 1 GA 8
		Develop the leadership capacity to negotiate intercultural learning spaces	GA 1 GA 6 GA 8
		Engage dialogically with distinct and/or intersecting intellectual communities to develop the scope of inquiry	GA 2 GA 3
PLO 2	Domain specific knowledge	Develop intensive and extensive knowledge and expertise in their respective domains	GA 1
		Formulate and extrapolate the knowledge gained to be applied in real– life situations, for self-directed learning and in competitive examinations	GA 1 GA 2 GA 3
		Evaluate and create domain specific	GA 1

		knowledge in areas of learning, research and industry	GA 2
PLO 3	Application oriented knowledge and diverse perspectives	Translate theoretical understanding to experimental knowledge for solving complex problems	GA 1 GA 3
		Ability to solve problems using pragmatic, alternative and creative approaches	GA 1 GA 2 GA 3 GA 5
		Capacity to apply advanced knowledge and approaches to solve concrete and abstract problems in domain-related and multi-disciplinary issues.	GA 1 GA 2
PLO 4	Innovation and research	Develop aptitude for innovation and entrepreneurship	GA 6
		Identify contemporary research problems, analyse data qualitatively and quantitatively and propose solutions	GA 1 GA 2 GA 9
		Create new ideas, analyse problems, diagnose them and identify their causes independently and/or in groups	GA 6 GA 7
PLO 5	Scientific communication skills	Document, prepare and present research work as reports and articles in academic forums	GA 6
		Critically assess, review and present theories and concepts	GA 1
		Take technically complex scientific topics and craft them into accessible, informative, and compelling content for specific audiences	GA 1 GA 2
PLO 6	Digital competency	Use domain-related advanced software resources, computational skills and digital tools for data analysis and interpretation	GA 2 GA 5
		Ethically apply digital skills to creatively communicate ideas and issues related to academic experiences	GA 5 GA 10
		Acquire the ability to leverage digital technologies to communicate, collaborate, and analyse data	GA 5
PLO 7	Ethical reasoning	Apply domain specific ethical principles and practices in academic, professional and social engagements	GA 1 GA 5

		Transform the behaviour of students to preserve public interest, the environment and be a source of help	GA 4 GA 5
		Being honest and taking responsibility for academic work and environmental sustainability	GA 4 GA 5
PLO 8	Comparative and interdisciplinary knowledge practices	Develop an interdisciplinary approach to research	GA 1 GA 7
		Compare scientific, social and historical phenomena in order to yield new insights	GA 1 GA 9
		Articulate how the complexities of social differentiation, like sex, gender, disability, race, ethnicity, nation, class, and such give insights and shape intellectual projects	GA 3 GA 5 GA 8 GA 9
PLO 9	Career readiness	Choose from diverse career options available in local, national and international realms.	GA 8
		Find success in workplace, manage one's career and apply the skills learned	GA 7
		Carry out further research or pursue higher education in the country or abroad	GA 1
PLO 10	Creating collaboration with the corporate world	Cultivate relationship with mentors and advisors, whose expertise and experience can assist in the development of work	GA 3 GA 7
		Recognize and reflect on the value, effectiveness, and ethics of collaboration in different settings and situations	GA 5 GA 9
		Produce new knowledge by working at the intersection of multiple disciplines and interdisciplinary fields	GA 1

METHODS OF EVALUATION

Evaluation	Methods	Marks
Internal	Continuous Internal Assessment Test	**40**
	Assignments / Snap Test / Quiz	
	Seminars	
External	End Semester Examination	**60**
Total		**100**

M.Sc. Physics CURRICULUM TABLE

Year	Semester	Module No.	Courses	Course Code	Hours: Lecture	Tutorial	Practical	Internship	Self-Learning	Demonstration	Research Project	Total Hours	Credits	Credit Points
I	I	**1.1**	Core Course 1 - **Mathematical Physics – I**	**23PP11**	6							**6**	**4**	**24**
		1.2	Core Course 2- **Classical Mechanics**	**23PP12**	6							**6**	**4**	**24**
		1.3	Core Course 3 - **Practical I- Electronics & Advanced Physics – I**	**23PPP1**			6					**6**	**4**	**24**
		1.4	**Discipline Specific Elective** 1- **Energy Physics**	**23PPEA**	**6**							**6**	**4**	**24**
		1.5	Discipline Specific Elective 2- **Linear Integrated Circuits**	**23PPEC**	6							**6**	**4**	**24**
		1.6	Project									**0**	**2**	**12**
			Total									**30**	**22**	**132**
I	II	2.1	Core Course 4 - **Solid State Physics – I**	**23PP21**	6							**6**	**4**	**24**
		2.2	Core Course 5 - **Mathematical Physics – II**	**23PP22**	6							**6**	**4**	**24**
		2.3	Core Course 6 - **Practical II - Electronics & Advanced Physics 2**	**23PPP2**			6					**6**	**4**	**24**

		2.4	**Discipline Specific Elective** 3- **Arduino Programming Theory**	**23PPEB**	**6**							**6**	**4**	**24**
		2.5	**Discipline Specific Elective** 4- **MATERIAL SCIENCE / MEDICINAL CHEMISTRY**	**23PPW1**	**6**							**6**	**4**	**24**
		2.6	**Project**									**0**	**2**	**12**
			Total									30	22	**132**
II	**III**	**3.1**	Core Course 7 - **Quantum Mechanics**	**23PP31**	6							**6**	**4**	**26**
		3.2	Core Course 8 - **Electro Magnetic Theory**	**23PP32**	6							**6**	**4**	**26**
		3.3	Core Course 9 - **Molecular Spectroscopy**	**23PP33**	5							**5**	**4**	**26**
		3.4	**Discipline Specific Elective** 5- **Practical – III Arduino Programming**	**23PPP3**			6					**6**	**4**	**26**
		3.5	**Discipline Specific Elective** 6- **Electronic Devices & Circuits / Material Science**	**23PPP3**	5							**5**	**4**	**26**
		3.6	**Project**									**2**	**2**	**13**
		3.7	**Internship**									**0**	**4**	**26**
			Total									30	26	**169**
II	**IV**	**4.1**	Core Course 10 - **Solid State Physics – II**	**23PP41**	6							**6**	**4**	**26**
		4.2	Core Course 11- **Statistics & Thermodynamics**	**23PP42**	6							**6**	**4**	**26**

		4.3	Core Course 12- **Nuclear & Particle Physics**	**23PP43**	6							**6**	**4**	**26**
		4.4	**Discipline Specific Elective** 7- **Theory - Numerical Methods & MATLab**	**23PPEE**	6							**6**	**4**	**26**
		4.5	**Discipline Specific Elective 8- Practical – IV Numerical Methods & MATLab**	**23PPP4**			6					**6**	**4**	**26**
				Total								30	20	**130**
	Total Credits for the PG Physics Programme												**90**	**563**

CREDIT LEVEL – 6

I SEMESTER

		PAPER TITLE	CREDITS	CREDIT POINTS	Hrs
Part I	Core Course – 1 **CC - 1**	**Mathematical Physics - I**	**4**	**24**	**6**
	Core Course – 2 **CC – 2**	**Classical Mechanics**	**4**	**24**	**6**
	Core Course – 3 **CC – 3**	**Practical – I Electronics & Advanced Physics - I**	**4**	**24**	**6**
	Discipline Specific Elective/Generic– 1 **DSE – 1**	**Energy Physics**	**4**	**24**	**6**
	Discipline Specific Elective/Generic –2 **DSE – 2**	**Digital Integrated Electronics**	**4**	**24**	**6**
		Total	**20**	**120**	**30**
	Project	**Project**	**2**	**12**	**0**
	Internship				
Total Credits for the PG Physics Programme			**22**	**132**	**30**

II SEMESTER

		PAPER TITLE	CREDITS	CREDIT POINTS	Hrs
Part I	Core Course – 4 **CC – 4**	**Solid State Physics - I**	**4**	**24**	**6**

	Core Course – 5 **CC – 5**	**Mathematical Physics - II**	**4**	**24**	**6**
	Core Course – 6 **CC – 6**	**Practical – II Electronics & Advanced Physics 2**	**4**	**24**	**6**
	Discipline Specific Elective/Generic– 3 **DSE – 3**	**Arduino Programming Theory**	**4**	**24**	**6**
	Discipline Specific Elective/Generic – 4 **DSE – 4**	**CHEMISTRY/PHYSICS Medicinal Chemistry/ Material Science**	**4**	**24**	**6**
		Total	**20**	**120**	**30**
	Project	**Project**	**2**	**12**	**0**
	Internship				
Total Credits for the PG Physics Programme			**22**	**132**	**30**

CREDIT LEVEL – 6.5

III SEMESTER

		PAPER TITLE	CREDITS	CREDIT POINTS	Hrs
Part I	Core Course – 7 **CC – 7**	**Quantum Mechanics**	**4**	**26**	**6**
	Core Course – 8 **CC – 8**	**Electro Magnetic Theory**	**4**	**26**	**6**
	Core Course – 9 **CC – 9**	**Molecular Spectroscopy**	**4**	**26**	**5**
	Discipline Specific Elective/Generic – 5 **DSE – 5**	**Practical – III Arduino Programming**	**4**	**26**	**6**
	Discipline Specific Elective/Generic – 6 **DSE – 6**	**Electronic Devices & Circuits / Material Science**	**4**	**26**	**5**
		Total	**20**	**130**	**28**
	Project	**Project**	**2**	**14**	**2**
	Internship **I - 1**		**4**	**26**	**0**
Total Credits for the PG Physics Programme			**26**	**170**	**30**

IV SEMESTER

		PAPER TITLE	CREDITS	CREDIT POINTS	Hrs
Part	Core Course – 10	**Solid State**	**4**	**26**	**6**

I	**CC – 10**	**Physics - II**			
	Core Course – 11 **CC – 11**	**Statistics & Thermodynamics**	**4**	**26**	**6**
	Core Course – 12 **CC – 12**	**Nuclear & Particle Physics**	**4**	**26**	**6**
	Discipline Specific Elective/Generic – 7 **DSE – 7**	**Theory - Numerical Methods & MATLab**	**4**	**26**	**6**
	Discipline Specific Elective/Generic – 8 **DSE – 8**	**Practical – IV Numerical Methods & MATLab**	**4**	**26**	**6**
	Project				
	Internship				
Total Credits for the PG Physics Programme			**20**	**130**	**30**

SEMESTER I

Course Title: **MATHEMATICAL PHYSICS – I**		Course Type: **Theory**
		Course Code: **23PP11**
Total Hours: **90**	Hours/Week: **6**	Credits: **4**
Pass-Out Policy : Minimum Contact Hours: **54** Total Score %: **100** Internal: **40** External: **60** Minimum Pass %: **50** [No Minimum for Internal]		
Course Creator:	**Expert 1:**	**Expert 2:**
Prof. A. Charles Hepzy Roy	**Dr. B.S. Benila**	**Dr. T.R. Beena**
Asso. Prof., Faculty Head	Asso. Prof. of Physics	Assi. Prof. of Physics
+919944261881	**+919843626563**	**9487386199**
achroy66@gmail.com	**benjanebenila@gmail.com**	**trbeena@gmail.com**

CLO-No.	Expected Course Learning Outcome *Upon completion of this course, the students will be able to:*	PLO % MAPPED WITH CLO	CLO & PLO MAPPED WITH GA	Cognitive Level CL	Knowledge Catogory KC
CLO-1	Explain linear dependence and linear combination of vectors as quantities in physics and identify various types of matrices and explain how one type of matrix differs from another. Recount functions like Alpha, Beta, Gamma and Green function	**1[10] 6[10]**	**1,2,3,5 ,6,8,10**	**U, Ap, An, E**	**C, P**
CLO-2	Understand the differentiation and integration of vector fields through vector calculus	**1[10] 6[10]**	**1,2,3,5 ,6,8,10**	**R, Ap, An, E**	**F, P**

CLO-3	Solve partial differential equations of second order that are common in physical sciences by making use of standard methods like separation of variables	**1[10] 6[10]**	**1,2,3,5,6,8,10**	**U, An, Ap, C**	**P, M**
CLO-4	Identify second order linear differential equation and find the linear independent solutions. Elaborate the orthogonal polynomials and other special functions	**1[10] 6[10]**	**1,2,3,5,6,8,10**	**U, Ap, An, C**	**F, M**
CLO-5	Master the basic elements of complex mathematical analysis, including the integral theorems, obtain the residues of a complex function and use the residue theorem to evaluate definite integrals in solving physical problems	**1[10] 6[10]**	**1,2,3,5,6,8,10**	**U, Ap, An**	**P, M**

Module	**Course Description**	**Hours**	**% CLO Mapping with Module**	**Learning Activitie**	**Assessment Tasks**	**Reference**
I	**VECTOR ALGEBRA, MATRICES & B,Γ, GREENS FUNCTIONS**					
1.1	Vector spaces – basis	1	1[10]	Lec	MCQ, Ess	1,4
1.2	Linearly dependent and independent set of vectors	1	1[10]	Lec	Ess	1,4
1.3	Schmitt's orthogonalization process	1	1[5]	Lec	SA	1,4
1.4	Rank of a matrix	1	1[10]	GD	Pro	1,4
1.5	Inverse of a matrix	1	1[5]	Lec	Pro	1,4
1.6	Caley Hamilton's theorem	1	1[10]	Lec	Ess	1,4
1.7	Eigenvalues and Eigenvectors	1	1[5]	Lec	SA	1,4
1.8	Diagonalisation of matrices	1	1[5]	GD	Pro	1,4
1.9	Beta and Gamma Functions	1	1[5]	Lec	SA	1,4
1.10	Evaluation of Beta Function	1	1[10]	TPS	SA	1,4
1.11	Transformation of Beta and Gamma functions	1	1[10]	GD	Sem	1,4
1.12	Relation between Beta and Gamma function	1	1[5]	Lec	Sem	1,4
1.13	Greens function– Solution to problems	1	1[10]	Lec	Ess	1,4
II	**VECTOR CALCULUS**					
2.1	Gradient of a scalar field	1	2[10]	Lec	MCQ, Ess	1,4
2.2	Line, surface and volume integrals	1	2[10]	GD	SA	1,4

2.3	Divergence of a vector function	1	2[10]	Lec	Ess	1,4
2.4	Curl of a vector function and its physical significance	1	2[5]	Lec	Ess	1,4
2.5	Gauss divergence theorem	1	2[10]	Lec	SA	1,4
2.6	Gauss's law in differential form	1	2[10]	Lec	SA	1,4
2.7	Deduction from Gauss divergence theorem	1	2[10]	Lec	Pro	1,4
2.8	Stoke's theorem	1	2[10]	Lec	Pro	1,4
2.9	Deductions from Stoke's theorem	1	2[5]	GD	Lec	1,4
2.10	Green's theorem	1	2[5]	Sem	Ess	1,4
2.11	Green's theorem in a plane	1	2[10]	Sem	SA	1,4
2.12	Orthogonal curvilinear coordinates	1	2[5]	Lec	Ess	1,4
III	**PARTIAL DIFFERENTIAL EQUATION**					
3.1	The equation of heat conduction	1	3[10]	Lec	MCQ, Ess	1
3.2	Variable linear flow	1	3[5]	Lec	Ess	1
3.3	Electrical analogy of linear heat flow:		3[5]	Lec	SA	1,2
3.4	Two dimensional heat conduction	1	3[10]	GD	Ess	1
3.5	Temperature in an infinite bar	1	3[10]	Lec	Qui, Ess	1
3.6	Temperature inside a circular plate	1	3[10]	Lec	Ess	1
3.7	The wave equation		3[10]	Lec	SA	1,2
3.8	The transverse vibration of stretched string	1	3[5]	GD	MCQ	1
3.9	Harmonic waves	1	3[5]	Sem	SA	1
3.10	D'Alembert's solution	1	3[5]	Sem	SA	1
3.11	Waves on strings	1	3[5]	Sem	MCQ	1
3.12	The vibration of a rectangular membrane	1	3[10]	Lec	Ess	1
3.13	The vibration of a circular membrane	1	3[10]	Lec	Ess	1
IV	**SPECIAL FUNCTIONS - I**					
4.1	linear differential equation of second order		4[10]	Lec	MCQ, Ess	1
4.2	Linear independence of solution	1	4[10]	GD	SA	1
4.3	Series solution of linear oscillator equation-Frobenius method	1	4[5]	Lec	Pro	1,2
4.4	Legendre differential equation – solution	1	4[10]	GD	Ess	1
4.5	Generating function	1	4[10]	Lec	Qui, Ess	1
4.6	Rodigue formula	1	4[5]	Lec	Ess	1
4.7	Orthogonal property	1	4[10]	Lec	Pro	1,2
4.8	Recurrence formula	1	4[10]	GD	MCQ, Pro	1
4.9	Hermite differential equation	1	4[10]	Sem	Ess	1

4.10	Generating function	1	4[5]	Lec	Ess	1
4.11	Rodigues formula	1	4[5]	Lec	Ess	1
4.12	Recurrence formula	1	4[5]	Lec	Ess	1
4.13	Orthogonal property	1	4[5]	Lec	Ess	1
V	**COMPLEX VARIABLE**					
5.1	Function of Complex Variable		5[10]	TPS	SA	1
5.2	Cauchy Riemann Condition	1	5[5]	Lec	Ess	3
5.3	Cauchy's Integral Theorem and Integral Formula	1	5[5]	Lec	Ess, Qui	3
5.4	Taylor's Series	1	5[5]	CS	Ess	3
5.5	Laurent's Series	1	5[5]	CS	Ess	3
5.6	Singularities of an Analytic Function	1	5[5]	Lec	SA	3
5.7	Cauchy's Residue Theorem		5[5]	Lec	Ess	3
5.8	Evaluation of Residues	1	5[5]	CL	Pro, MCQ	3
5.9	Evaluation of Definite Integrals: Integration Around Unit Circle	1	5[10]	CL	Ess, Pro	3
5.10	Evaluation of Certain Integrals Between $+\alpha$ and $-\alpha$	1	5[5]	CL	Pro	3
5.11	Jordan's Lemma	1	5[5]	Lec	SA	3
5.12	Intending the Contour	1	5[10]	Lec	SA	3
5.13	Integrals Involving Multiple Valued Function (Branch Points)	1	5[5]	GD	Ess	3
5.14	Problems related to complex variables, Cauchy's Residue Theorem and Integration	1	5[10]	GD	Pro	3

BOOKS FOR REFERENCE:

1. Satyaprakash, Mathematical Physics, S. Chand, Co., New Delhi, 1994.
2. L.A. Pipes and L.R. Harvill, Applied Mathematics for Engineers and Physicists, McGraw Hill Co., 1970.
3. Erwin Kreyszig, Advanced Engineering Mathematics, Wiley Eastern Ltd., 1989.
4. Eugene Budkov, Mathematical Physics, Addision Wesley Publishing Co., 1973
5. George B. Arfkan & Hans J. Weber, Mathematical Methods for Physicists, Harcourt (India) Pvt., Ltd., 2007.

Course Title:	**CLASSICAL MECHANICS**	Course Type: **Theory**
		Course Code: **23PP12**
Total Hours: **90**	Hours/Week: **6**	Credits: **4**
Pass-Out Policy : Minimum Contact Hours: 54		

Total Score %: **100**	Internal: **40**	External: **60**
Minimum Pass %: **50** [No Minimum for Internal]		
Course Creator:	**Expert 1:**	**Expert 2:**
Prof. A. Charles Hepzy Roy	**Dr. J.V. Bynaja**	**Dr. Y. Sheeba Sherlin**
Asso. Prof., Faculty Head	Asso. Prof. of Physics	Asso. Prof. of Physics
+919944261881	**+919444384135**	**+919442304397**
achroy66@gmail.com	**bynaja@gmail.com**	**ysheebamohan@ gmail.com**

CLO No.	**Expected Course Learning Outcome** *Upon completion of this course, the students will be able to:*	PLO % MAPPED WITH CLO	CLO & PLO MAPPED WITH GA	Cognitive Level CL	Knowledge Catogory KC
CLO-1	Gain deeper understanding of classical mechanics. Consolidate the understanding of fundamental concepts in mechanics such as force, energy, momentum etc.	**2[10] 5[10]**	**1,2,3,6**	**U Ap**	**C, F**
CLO-2	Evaluate the equations of motion for complicated mechanical systems using the Lagrangian and Hamiltonian formulation of classical mechanics.	**2[10] 5[10]**	**1,2,3,6**	**U Ap An**	**F, P**
CLO-3	Solve the Newton equations for simple configurations using various methods	**2[10] 5[10]**	**1,2,3,6**	**Ap E**	**C, P**
CLO-4	Understand the foundations of Non-linear dynamics, Chaotic motion, etc.	**2[10] 5[10]**	**1,2,3,6**	**An E**	**P**
CLO-5	Learn and apply mathematical techniques and methods of use to physicists in solving problems.	**2[10] 5[10]**	**1,2,3,6**	**U Ap**	**P, M**

Module	**Course Description**	**Hours**	**% CLO Mapping with Module**	**Learning Activitie**	**Assessment Tasks**	**Reference**
I	**LAGRANGIAN FORMULATION**					
1.1	Mechanics of a single particle	1	1[10]	Lec	SA	1
1.2	Mechanics of a system of particles	1	1[5]	GD	Ess	1
1.3	Constraints: Define and Classification holonomic, non-holonomic, rheonomic, scleronomic	2	1[10]	Lec	Ess	1
1.4	Generalised coordinates – definition and explanation	0.5	1[10]	Lec	Ess	1
1.5	Principle of virtual work – statement	0.5	1[10]	Lec	Ess	1

	and proof					
1.6	D'Alembert's principle – statement and proof	0.5	1[10]	OO	SA	1
1.7	Lagranges equation using D'Alembert's principle:	1	1[5]	Lec	SA	1
1.8	Conservative system	0.5	1[10]	Lec	SA	1
1.9	non-conservative system	0.5	1[10]	Lec	SA	1
1.10	Application 1: Single particle in space	0.5	1[10]	Lec	Pro	1
1.11	Cartesian coordinates	1	1[5]	GD	Lec	1
1.12	Plane polar coordinates	1	1[5]	Sem	Ess	1
1.13	Application 2: Atwoods machine	0.5	1[5]	Sem	SA	1
1.14	Application 3: Bead sliding on a uniformly rotating wire in a force free space	0.5	1[5]	Lec	Ess	1
II	**HAMILTONIAN FORMULATION**					
2.1	Hamilton's principle – statement and explanation	0.5	2[10]	Lec	MCQ, Ess	2
2.2	Derivation of Lagrange's equation form Hamilton's principle.	1	2[5]	GD	SA	2
2.3	Hamilton's equations of motion	1	2[10]	Lec	Ess	2
2.4	Applications of Hamiltonian formulation	1	2[5]	Lec	Ess	2
2.5	Simple pendulum with moving support	0.5	2[10]	Lec	SA	2
2.6	Charged particle in an electromagnetic field	0.5	2[10]	Lec	SA	2
2.7	Canonical transformation equations	1	2[5]	Lec	Pro	2
2.8	Application – solving simple harmonic oscillator problem using canonical transformation	1	2[10]	Lec	Pro	2
2.9	Hamilton Jacobi theory	1	2[5]	GD	Lec	2
2.10	Application – solving simple harmonic oscillator problem by Hamilton Jacobi theory	1	2[5]	Sem	Ess	2
2.11	Poisson's bracket	1	2[10]	Sem	SA	2
2.12	Properties of Poisson brackets	0.5	2[5]	Lec	Ess	2
2.13	Fundamental Poisson brackets	1	2[5]	Lec	SA	2
2.14	Lagrange's bracket – relation between Lagrange and Poisson brackets	1	2[5]	Lec	Pro	2
III	**MOTION OF A PARTICLE IN A CENTRAL FORCE FIELD**					
3.1	Motion of a particle in a central force – bounded and unbounded motion with	1	3[10]	Lec	MCQ, Ess	2

	examples					
3.2	Equivalent one body problem – reduced mass	1	3[5]	Lec	Ess	2
3.3	Motion in a central force field	1	3[5]	Lec	SA	2
3.4	Component of L along any axis through the centre of force is constant	1	3[10]	GD	Ess	2
3.5	Areal velocity is constant	0.5	3[5]	Lec	Ess	2
3.6	Total energy E is constant of motion	1	3[5]	Lec	Ess	2
3.7	General features of motion	1	3[10]	Lec	SA	2
3.8	Equivalent one dimensional problem	1	3[5]	GD	MCQ	2
3.9	Motion in an arbitrary potential field	1	3[5]	Sem	SA	2
3.10	Motion in an inverse square law force field	1	3[5]	Sem	SA	2
3.11	Equation of the orbit	0.5	3[5]	Sem	MCQ	2
3.12	Eccentricity	1	3[10]	Lec	Ess	2
3.13	Nature of the orbits	1	3[10]	Lec	Ess	2
3.14	Kepler's laws of planetary motion	0.5	3[5]	Lec	Ess	2
3.15	Kepler's III law verification – determination of mass of sun from Kepler's III law	0.5	3[5]	Lec	Ess	2
IV	**COLLISIONS OF PARTICLES AND SCATTERING**					
4.1	Introduction – angle of scattering	0.5	4[10]	Lec	Ess	1
4.2	Elastic and inelastic scattering	0.5	4[10]	GD	SA	1
4.3	Elastic scattering	1	4[5]	Lec	Pro	1,2
4.4	Laboratory and centre of mass systems – definitions with figures	1	4[10]	GD	Ess	1
4.5	Linear momenta are equal and opposite	1	4[10]	Lec	Qui, Ess	1
4.6	Velocities of the particles in the CM system are equal	1	4[5]	Lec	Ess	1
4.7	Total kinetic energy is equal before and after scattering	1	4[10]	Lec	Pro	1,2
4.8	Relations between different quantities in the laboratory and CM System	1	4[10]	GD	MCQ, Pro	1
4.9	Kinematics of elastic scattering in the laboratory system	1	4[10]	Sem	Ess	1
4.10	To show that the heavy particle hardly deviates from its path	1	4[5]	Lec	Ess	1
4.11	Loss of kinetic energy	0.5	4[5]	Lec	Ess	1
4.12	Inelastic scattering	0.5	4[5]	Lec	Ess	1
4.13	Endoergic and exoergic reactions To prove the condition for reaction, $Q + T_1$	1	4[5]	Lec	Ess	1

	≥0					
4.14	Cross-sections – Differential and total scattering cross sections	0.5	4[5]	CL	SA	2
4.15	Rutherford scattering cross-section formula	0.5	4[5]	CL	Ess	2
V	**NON-LINEAR DYNAMICS**					
5.1	Dynamical System: Linear and Non-Linear forces	1	5[10]	TPS	SA	3
5.2	Mathematical Implications of Non-linearity: Linear and Non- Linear systems	1	5[10]	Lec	Ess	3
5.3	Effects of Non-linearity	1	5[10]	Lec	Ess,	3
5.4	Linear Oscillations: Free Oscillations-Damped Oscillations-Forced Oscillations	1	5[10]	CS	Ess	3
5.5	Non-linear Oscillations	1	5[10]	CS	Ess	3
5.6	Bifurcations	1	5[5]	Lec	SA	3
5.7	Classification of Equilibrium points-2D case: General criteria for stability-Classification of equilibrium(Singular points)	1	5[10]	Lec	Ess	3
5.8	Limit Cycle motion	1	5[10]	CL	Pro,	3
5.9	Periodic attractor	1	5[10]	CL	Ess,	3
5.10	Poincare-Bendixson theorem	1	5[10]	CL	Pro	3
5.11	Fermi Pasta Ulam experiment	1	5[5]	Lec	SA	3

BOOKS FOR REFERENCE:

1. Herbert Goldstein, Classical Mechanics, Addison-Wisley Publishing Co., London, 1980.
2. R.G. Takwale & P. Puranik, Introduction to Classical Mechanics, Tata McGraw Hill Publishing Co., Ltd., New Delhi, 1983.
3. M. Lakshmanan and S. Rajasekar, "Nonlinear Dynamics: Integrability Chaos and Pattern", Springer Verlag, Berlin, 2003.
4. Greiner, Classical Mechanics, Springer, Springer International Edition, New York, 2004.
5. Goldstein, Poole & Safko, Classical Mechanics, Pearson Education, New York, 2004.
6. N.C. Rana, P.S. Joag, Classical Mechanics, Tata McGraw Hill, New Delhi, 2004.
7. M. Lakshmanan and K. Murali, Chaos in Nonlinear oscillators, World Scientific Co., Singapore, 1996.

Course Title:	**ELECTRONICS & ADVANCED PHYSICS I**	Course Type: **Practical**
		Course Code: **23PPP1**
Total Hours: **90**	Hours/Week: **6**	Credits: **4**
Pass-Out Policy : Minimum Contact Hours: 54 Total Score %: **100** Internal: **40** External: **60** Minimum Pass %: **50** [No Minimum for Internal]		

Course Creator:	**Expert 1:**	**Expert 2:**
Prof. A. Charles Hepzy Roy	**Dr. D.J. Jeejamol**	**Dr. H. Adlin Mahiba**
Asso. Prof., Faculty Head	Assi. Prof. of Physics	Assi. Prof. of Physics
+919944261881	**+917598629087**	**+91 9486578077**
achroy66@gmail.com	**lomajeej@gmail.com**	**adlinemahiba1@gmail.com**

CLO No.	**Expected Course Learning Outcome** *Upon completion of this course, the students will be able to:*	PLO % MAPPED WITH CLO	CLO & PLO MAPPED WITH GA	Cognitive Level CL	Knowledge Catogory KC
CLO-1	Improve the analytical and observation ability in Physics Experiments to determine any physical constant for materials;	**5[10] 9[10]**	**1,2,6,7, 8**	**U Ap**	**P**
CLO-2	Get an in-depth knowledge on designing electronic circuits;	**5[10] 9[10]**	**1,2,6,7, 8**	**U Ap An**	**F, P**
CLO-3	Familiarize in extracting circuit parameters.	**5[10] 9[10]**	**1,2,6,7, 8**	**Ap E**	**C, P**
CLO-4	The students will be able to use the different components and equipment in physics practical.	**5[10] 9[10]**	**1,2,6,7, 8**	**An E**	**P**
CLO-5	The students will also able to work effectively and safely in the laboratory environment independently and as well as in teams.	**5[10] 9[10]**	**1,2,6,7, 8**	**Ap C**	**P, M**

No.	Course Description
1	Determination of Young's modulus and Poisson's ratio by Hyperbolic fringes.- Cornu's Method
2	Determination of Viscosity of the given liquid.-Meyer's disc
3	Measurement of Coefficient of linear expansion- Air Wedge Method
4	Determination of thickness of the enamel coating on a wire by diffraction
5	Determination of Rydberg's constant -Hydrogen spectrum
6	Measurement of Band gap energy- Thermistor.
7	Determination of Planck's constant-LED Method
8	Determination of Specific charge of an electron-Thomson's Method
9	Determination of Compressibility of a liquid using Ultrasonics
10	Measurement of conductivity- Four probe method
11	Find the wavelength of diode laser/He-Ne Laser using diffraction grating
12	Determination diffraction pattern of light with circular aperture using diode

	/He-Ne laser
13	Construction of relaxation oscillator using UJT
14	Characteristics of FET
15	V- I Characteristics of different colours of LED
16	Study of important electrical characteristics of IC741
17	Construction of Schmidt trigger circuit using IC 741 for a given hysteresis-application as squarer
18	Construction of square wave &TRIANGULAR WAVE generator using IC 741
19	Construction of pulse generator using the IC 741 – Application of Frequency divider
20	Construction of pulse generator using the IC 555 – Application as frequency divider
21	Study of Binary to Gray and Gray to Binary code conversion
22	Construction of Op-Amp- 4 bit Digital to Analog converter (Binary Weighted and R/2R ladder type)
23	Basic gates (OR, AND, NOT, XOR) from Universal gates - NAND and NOR
24	Study of R-S, clocked R-S and D-Flip flop using NAND gates

BOOKS FOR REFERENCE

1. S.P. Singh, Advanced Practical Physics, Vol. I & II, Pragati Prakashan, New Delhi, 2001.
2. F. Tyler , A Lab Manual of Physics, Edward Arnold Publisher Ltd., 1970.
3. C.L. Arora, Practical Physics, S. Chand & Co., New Delhi, 2001
4. K.A. Navas, Electronics Laboratory Manual, vol. I, IV Ed., Rajath Publisher, Ernakulam
5. Navas, Elevtronic Laboratory Manual, vol. II., IV Ed., Rajath Publisher, Ernakulam
6. J.D. Karyachen, S. Shyam Mohan, Electronics Lab Manual, vol. II, Ayodhaya Publication II Ed., Kottayam, 2011
7. Kar, Advanced Practical Electronics, Books and Allied (P) Ltd, Kolkatta, 2010

Course Title:	**ENERGY PHYSICS**	Course Type: **Theory**
		Course Code: **23PPEA**
Total Hours: **90**	Hours/Week: **6**	Credits: **4**
Pass-Out Policy : Minimum Contact Hours: 54 Total Score %: **100** Internal: **40** External: **60** Minimum Pass %: **50** [No Minimum for Internal]		

Course Creator:	Expert 1:	Expert 2:
Prof. A. Charles Hepzy Roy	**Dr. Y. Premila Rachelin**	**Dr. H. Adlin Mahiba**
Asso. Prof., Faculty Head	Asso. Prof. of Physics	Assi. Prof. of Physics
+919944261881	**+919489620591**	**+91 9486578077**
achroy66@gmail.com	**premilarachelin@gmail.com**	**adlinemahiba1@gmail.com**

CLO No.	**Course Learning Outcome** *Upon completion of this course, students will be able to:*	PLO % MAPPED WITH CLO	CLO & PLO MAPPED WITH GA	Cognitive Level CL	Knowledge Catogory KC
CLO- 1	To identify various forms of renewable and non-renewable energy sources.	**1[20]**	**1,2,3,6, 8**	**R**	**C**
CLO- 2	Understand the principle of utilizing the oceanic energy and apply it for practical applications.	**1[20]**	**1,2,3,6, 8**	**U**	**F**
CLO- 3	Discuss the working of a windmill and analyze the advantages of wind energy.	**1[20]**	**1,2,3,6, 8**	**Ap**	**C, P**
CLO- 4	Distinguish aerobic digestion process from anerobic digestion	**1[20]**	**1,2,3,6, 8**	**Ap, An**	**F, P**
CLO- 5	Understand the components of solar radiation, their measurement and apply them to utilize solar energy	**1[20]**	**1,2,3,6, 8**	**U, E**	**P,M**

Module	Course Description	Hours	% CLO Mapping with Module	Learning Activitie	Assessment Tasks	Reference
I	**INTRODUCTION TO ENERGY SOURCES**					
1.1	Conventional energy sources	2	1[10]	Lec	MCQ, Ess	1
1.2	Non-Conventional energy sources	2	1[10]	Lec	Ess	1
1.3	Availability of energy sources	2	1[5]	Lec	SA	1
1.4	Prospects of Renewable energy sources	1	1[10]	GD	Pro	1
1.5	Energy from other sources	2	1[5]	Lec	Pro	1
1.6	Chemical energy	1	1[10]	Lec	Ess	1
1.7	Nuclear energy	2	1[5]	Lec	SA	1
1.8	Geo thermal energy	2	1[5]	GD	Pro	1

1.9	Hydraulic energy	1	1[5]	Lec	SA	1
1.10	Energy storage and distribution	2	1[10]	TPS	SA	1
II	**ENERGY FROM THE OCEANS**					
2.1	Energy Utilization	1	2[10]	Lec	MCQ, Ess	1
2.2	Energy from tides	2	2[10]	GD	SA	1
2.3	Ocean thermal energy	1	2[10]	Lec	Ess	1
2.4	Basic principles of tidal power	1	2[5]	Lec	Ess	1
2.5	Component of Tidal power plant	1	2[10]	Lec	SA	1
2.6	Operation methods of Utilization of tidal energy	2	2[10]	Lec	SA	1
2.7	Prospects of Tidal energy in India	1	2[10]	Lec	Pro	1
2.8	Principle of Ocean Thermal energy conversion	2	2[10]	Lec	Pro	1
2.9	Open cycle OTEC System-Closed cycle OTEC system	1	2[5]	GD	Lec	3
2.10	Prospects of OTEC in India	1	2[5]	Sem	Ess	1
III	**WIND ENERGY SOURCES**					
3.1	Basic principles of Wind energy	1	3[10]	Lec	MCQ , Ess	1
3.2	Wind velocity	1	3[5]	Lec	Ess	1
3.3	Wind energy conversion Principles	1	3[5]	Lec	SA	2
3.4	Power in Wind	1	3[10]	GD	Ess	2
3.5	Force in the blades	1	3[10]	Lec	Qui, Ess	1
3.6	Advantages and disadvantages of wind energy conversion systems (WECS)	1	3[10]	Lec	Ess	1
3.7	Energy storage	1	3[10]	Lec	SA	2
3.8	Application of Wind energy- Pumping applications	1	3[5]	GD	MCQ	1
3.9	Direct heat applications	1	3[5]	Sem	SA	2
3.10	Electric generation applications	1	3[5]	Sem	SA	2
IV	**ENERGY FROM BIOMASS**					
4.1	Biomass conversion technologies	1	4[10]	Lec	Qui	2
4.2	Wet and dry Process	1	4[10]	Lec	SA	2
4.3	Photosynthesis	1	4[5]	Lec	SA	2
4.4	Biogas generation	1	4[10]	GD	Ass	1
4.5	Introduction-basic process:Aerobic and anaerobic digestion	1	4[10]	Lec	Qui	1
4.6	Advantages of anaerobic digestion	1	4[5]	GD	SA	2
4.7	Factors affecting bidirectional and generation of gas	1	4[10]	GD	Ess	2
4.8	Biogas from waste food	1	4[10]	GD	MCQ	1
4.9	Properties of biogas	1	4[10]	Lec	SA	1

4.10	Utilization of biogas	1	4[5]	EL	Ess	1
V	**SOLAR ENERGY SOURCES**					
5.1	Solar radiation and its measurement	1	5[10]	Lec	Ass	2
5.2	Solar cells	1	5[5]	EL	Sem	1
5.3	Solar cells for direct conversion of solar energy to electric power	1	5[5]	EL	Sem	1
5.4	Solar cell parameter-solar cell electrical characteristics	1	5[5]	CS	Ess	4
5.5	Efficiency	1	5[5]	Lec	Qui	4
5.6	Solar water heater	1	5[5]	EL	Ess	1
5.7	Solar distillation	1	5[5]	Lec	SA	1
5.8	Solar cooking	1	5[5]	EL	Ess	1
5.9	Solar green house	1	5[10]	*GD*	*Sem*	1
5.10	Solar pond and its applications	1	5[5]	GD	Ess	1

BOOKS FOR REFERENCE:

1. G.D. Rai, 1996, Non-convention sources of, 4th edition, Khanna publishers, New Delhi.
2. S. Rao and Dr. ParuLekar, Energy technology.
3. M. P. Agarwal, Solar Energy, S. Chand and Co. New Delhi (1963)
4. Solar energy, principles of Thermal collection and storage by S. P. Sukhatme. 2nd edition, Tata McGraw-Hill Publishing Co. Lt, New Delhi (1997)
5. Energy Technology by S. Rao and Dr. Parulekar

Course Title: **DIGITAL INTEGRATED ELECTRONICS**		Course Type: **Theory**
		Course Code: **23PPEC**
Total Hours: **90**	Hours/Week: **6**	Credits: **4**
Pass-Out Policy : Minimum Contact Hours: 54 Total Score %: **100** Internal: **40** External: **60** Minimum Pass %: **50** [No Minimum for Internal]		
Course Creator:	**Expert 1:**	**Expert 2:**
Prof. A. Charles Hepzy Roy	**Dr. D. Hudson Oliver**	
Asso. Prof., Faculty Head	Assi. Prof. of Physics	
+919944261881	**+919952654515**	
achroy66@gmail.com	**hudson2612@gmail.com**	

CLO No.	**Expected Course Learning Outcome** ***Upon completion of this course, the students will be able to:***	**PLO % MAPPED WITH CLO**	**CLO & PLO MAPPED WITH GA**	**Cognitive Level CL**	**Knowledge Category KC**
CLO- 1	Understanding regarding basic logic circuits	**5[10] 6[10]**	**1,2,5 ,6,10**	U, Ap, An, C	C, P

CLO- 2	Knowledge in basic memory elements	**5[10] 6[10]**	**1,2,5 ,6,10**	U, Ap, An	C, P
CLO- 3	Idea in designing binary and non-binary counters	**5[10] 6[10]**	**1,2,5 ,6,10**	Ap, An, E	C, P, M
CLO- 4	Expertise in designing memory cells	**5[10] 6[10]**	**1,2,5 ,6,10**	Ap, An, C	F, C, P
CLO- 5	Understanding and applying the concept of signal transfer incircuits	**5[10] 6[10]**	**1,2,5 ,6,10**	U, Ap, An, C	C, P, M

Module	**Course Description**	**Hours**	**% CLO Mapping with Module**	**Learning Activitie**	**Assessment Tasks**	**Reference**
I	**Logic Circuits**					
1.1	The resistor transistor logic	1	1[10]	Lec	Qui	1
1.2	Fan out in RTL	1	1[10]	OO	MCQ	1
1.3	Input / output characteristics of RTL	1	1[5]	BS	Ass	1
1.4	Diode transistor logic	0.5	1[5]	PT	SA	1
1.5	Fan out in DTL	1	1[10]	GD	Sem	1
1.6	Input / output characteristics of DTL	1	1[10]	GT	Ass	1
1.7	Transistor – Transistor logic	1	1[10]	PT	Qui	1
1.8	Input volt ampere characteristics of TTL	0.5	1[10]	Lec	Ass	1
1.9	Emitter coupled logic gates	1	1[5]	PT	SA	1
1.10	MOS gates	1	1[5]	GD	Sem	1
1.11	Rise time and fall time	1	1[10]	Lec	Qui	1
1.12	CMOS gates	1	1[10]	TPS	Sem	1
II	**Flip Flops**					
2.1	Flip Flop as a memory element	1	2[10]	TPS	Sem	1
2.2	Flip Flop using NAND gates	1	2[5]	EL	MPr	1
2.3	Clocked flip-flops (need for a clock)	1	2[10]	SI	Ass	1
2.4	The Master slave flip flop	1	2[10]	GT	Ass	1
2.5	AC coupled edge triggered flip flop	1	2[10]	Lec	Ess	1
2.6	Propagation delay flip flop	1	2[5]	EL	Qui	1
2.7	J.K. flip flop	1	2[10]	GD	Ass	1
2.8	The clocked A.C. coupled flip flop	1	2[10]	PT	Ess	1
2.9	The ECL flip flop	1	2[10]	OO	Qui	1
2.10	MOS flip flops	1	2[10]	CL	Sem	1
2.11	Type D – MOS flip flops	1	2[10]	PT	Ass	1
III	**Registers and Counters**					
3.1	The shift Register	1	3[5]	TPS	Sem	1
3.2	Clocking	1	3[5]	GD	Ass	1

3.3	Serial-parallel data transfer	1	3[10]	GT	Qui	1
3.4	End around carry	1	3[10]	PT	Ess	1
3.5	Shift right register	1	3[5]	TPS	Sem	1
3.6	Shift left register	1	3[10]	TPS	Sem	1
3.7	Ripple counter	2	3[5]	Lec	Ass	1
3.8	Method to improve the counter speed	1	3[10]	Lec	Qui	1
3.9	Non binary counter	1	3[10]	SI	SA	1
3.10	Mod 3 counter	1	3[10]	EL	Ass	1
3.11	Up-down ripple counter	1	3[5]	GD	Sem	1
3.12	The up-down synchronous counter	1	3[5]	Lec	Qui	1
3.13	Ring counter	1	3[5]	TPS	Sem	1
IV	**Semiconductor Memories**					
4.1	Types of memories	1	4[10]	TPS	Sem	1
4.2	Shift register sequential memories	1	4[10]	Lec	Ass	1
4.3	MOS register stages	2	4[10]	PT	Qui	1
4.4	CMOS register stages	1	4[10]	PT	Qui	1
4.5	The read only memory (ROM)	1	4[10]	GT	SA	1
4.6	Implementation of ROMs	1	4[10	GD	Ass	1
4.7	Programmable and Erasable ROM	1	4[10]	Lec	Ass	1
4.8	Applications of ROM	1	4[10]	OO	Ess	1
4.9	Bipolar function Transistor Random AccessMemory Cell (RAM)	1	4[5]	PT	MCQ	1
4.10	MOS RAMs	1	4[5]	CS	Ass	1
4.11	Organization of RAM	1	4[5]	Lec	MCQ	1
4.12	Charge Couple Devices (CCD)		4[5]	CL	Sem	1
V	**Switches and Converters**					
5.1	Diode gate	1	5[10]	Lec	Ass	1
5.2	Transistor gate	1	5[10]	OO	Qui	1
5.3	FET gate	1	5[5]	GD	Sem	1
5.4	CMOS gate	1	5[10]	PT	Sem	1
5.5	Application of analog switches	1	5[10]	Lec	Ass	1
5.6	Sampling theorem	2	5[5]	GT	MCQ	1
5.7	Time division multiplexing	1	5[10]	CS	Ess	1
5.8	Quantization	1	5[10]	TPS	Sem	1
5.9	The weighed resistor D/A convertor-R-2Rladder converter	1	5[10]	EL	Ass	1
5.10	A/D converter	1	5[10]	EL	Ass	1
5.11	Parallel comparator type	1	5[5]	PT	Sem	1
5.12	Successive approximation converter		5[5]	Lec	Ass	1

BOOKS FOR REFERENCE:

1. Herbert Taub and Donald Schilling, Digital Integrated Electronics, McGraw-HillInternational Editions, New Delhi (1989).
2. Albert Paul Malvino and Donald P Leach, Digital Principles and Applications,McGraw HillInternational Editions, New Delhi 1969).
3. M. Morris Mano, Digital Logic and Computer Design, Prentice Hall of

IndiaPVT. Ltd, NewDelhi (2001).

SEMESTER II

Course Title:	**SOLID STATE PHYSICS – I**	Course Type: **Theory**
		Course Code: **23PP21**
Total Hours: 9**0**	Hours/Week: **6**	Credits: **4**
Pass-Out Policy : Minimum Contact Hours: 54 Total Score %: **100**	Internal: **40**	External: **60**
Minimum Pass %: **50**	[No Minimum for Internal]	
Course Creator:	**Expert 1:**	**Expert 2:**
Prof. A. Charles Hepzy Roy	**Dr. C. Besky Job**	**Dr. Y. Sheeba Sherlin**
Asso. Prof., Faculty Heac	Asso. Prof. of Physics	Asso. Prof. of Physics
+919944261881	**+919487026024**	+919442304397
achroy66@gmail.com	**cbjob1969@gmail.com**	**ysheebamohan@gmail.com**

CLO No.	Expected Course Learning Outcome *Upon completion of this course, students will be able to:*	PLO % MAPPED WITH CLO	CLO & PLO MAPPED WITH GA	Cognitive Level CL	Knowledge Catogory KC
CLO- 1	Understanding position of atoms in crystal lattice and to name the crystal planes in terms of Miller Indices and Skills in tracing elastic waves in crystals	**2[10] 7[10]**	**1,2,3**	**R, U**	**C, F**
CLO- 2	Perspective in the concept of constructing reciprocal lattice	**2[10] 7[10]**	**1,2,3**	**U, Ap**	**F, P**
CLO- 3	Awareness in confirming the dielectric properties of crystals	**2[10] 7[10]**	**1,2,3**	**An**	**P**
CLO- 4	In-depth knowledge in phonon vibration and the resulted thermal anomalies	**2[10] 7[10]**	**1,2,3**	**An, E**	**P, M**
CLO- 5	Knowledge regarding the structural thermal, optical, electrical, dielectric, dielectric properties of solids	**2[10] 7[10]**	**1,2,3**	**E, C**	**F, M**

Module	Course Description	Hours	% CLO Mapping with Module	Learning Activitie	Assessment Tasks	Reference
I	**CRYSTAL STRUCTURE**					
1.1	Some fundamental definitions in Crystallography	1	1[5]	Lec	SA, Qui	1,2
1.2	Lattice parameters of an unit cell	0.5	1[10]	Lec	SA,	1,2

1.3	Hexagonal close packed structure	1.5	1[10]	Lec	Ess	1,2
1.4	Diamond cubic structure	0.5	1[5]	GD	SA, MCQ	1,2
1.5	Sodium chloride structure	0.5	1[10]	GD	SA, Qui	1,2
1.6	Cesium chloride structure	0.5	1[5]	GD	SA, Qui	1,2
1.7	Miller indices	1	1[5]	Lec	SA, Pro	1,2
1.8	Polymorphism and Allotrophy	1	1[5]	Lec	SA	1,2
1.9	Vanderwalls London interaction	1	1[10]	Lec	Ess	1,2
1.10	Elastic compliance and Stiffness constants	1	1[10]	Lec	Ess	1,2
1.11	Bulk miodulus and compressibility	1	1[10]	GD	SA	1,2
1.12	Elastic waves in cubic crystals	1.5	1[10]	Lec	Ess	1,2
1.13	Waves in the (100), (110) direction	1	1[5]	Lec	Ess	1,2
II	**RECIPROCAL LATTICE**					
2.1	Diffraction of waves by crystals	0.5	2[10]	Lec	SA	1,2
2.2	Scattered wave amplitude	0.5	2[10]	Lec	SA, Qui	1,2
2.3	Fourier analysis	1	2[5]	Lec	Ess, MCQ	1,2
2.4	Reciprocal lattice vectors	1	2[5]	Lec	SA	1,2
2.5	Diffraction conditions	0.5	2[5]	GD	SA, MCQ	1,2
2.6	Laue equations	0.5	2[5]	Lec	Ess	1,2
2.7	Brillouin zones	1	2[5]	BS	Ess	1,2
2.8	Reciprocal lattice to sc lattice	0.5	2[10]	BS	Ess	1,2
2.9	Reciprocal lattice to bcc lattice	0.5	2[10]	BS	Ess	1,2
2.10	Reciprocal lattice to fcc lattice	1	2[10]	BS	Ess	1,2
2.11	Fourier analysis of the basis	1	2[5]	Lec	SA	1,2
2.12	Structure factor of the bcc lattice	1	2[5]	Lec	SA	1,2
2.13	Structure factor of the fcc lattice	1	2[5]	PT	Ess	1,2
2.14	Atoms form factor	1	2[5]	PT	Ess	1,2
2.15	Quasi crystals	1	2[5]	CL	Ass	1,2
III	**DIELECTRIC PROPERTIES OF CRYSTALS**					
3.1	Fundamental definitions in Dielectrics	1	3[10]	GD	SA, Qui	1,2
3.2	Polarization	0.5	3[5]	Lec	SA	1,2

3.3	Dielectric constant and Polarizability	0.5	3[10]	Lec	SA	1,2
3.4	Electronic polarizability	1	3[5]	Lec	Ess	1,2
3.5	Frequency and temperature effects of polarization	1	3[10]	Lec	Ess	1,2
3.6	Dielectric loss	1	3[5]	Lec	Ess, Pee	1,2
3.7	Application of dielectric materials	1	3[10]	GD	SA, Ess	1,2
3.8	Ferro electric crystals	0.5	3[10]	PT	SA	1,2
3.9	Classification of Ferro electric crystals	1	3[5]	Lec	Ess	1,2
3.10	Properties of Ferro electric materials	1.5	3[5]	PT	SA	1,2
3.11	Landau theory of phase transition	1	3[5]	Lec	Ess	1,2
3.12	Anti Ferro Electricity	0.5	3[10]	PT	SA, MCQ	1,2
3.13	Ferro electric domains	0.5	3[5]	PT	SA, MCQ	1,2
3.14	Piezo electricity	1	3[5]	Lec	Ess	1,2
IV	**PHONONS CRYSTAL VIBRATIONS**					
4.1	Vibrations of crystals with monoatomic basis	1	4[5]	Lec	SA, Qsd	1,2
4.2	First brilloune zone	1	4[10]	Lec	Ess	1,2
4.3	Group velocity	0.5	4[5]	Lec	SA, pro	1,2
4.4	Long wave length limit	0.5	4[10]	Lec	SA, Pro	1,2
4.5	Derivation of force constants from Experiment	1	4[10]	Lec	Ess	1,2
4.6	Two atoms per primitive basis	1	4[10]	Lec	Ess	1,2
4.7	Quantization of elastic waves	1	4[10]	BS	SA	1,2
4.8	Phonon momentum	1	4[5]	BS	SA, Pro	1,2
4.9	Selection rule	0.5	4[5]	Lec	SA	1,2
4.10	Facts about diatomic lattice	1	4[10]	GD	Ess	1,2
4.11	Optical branch of diatomic lattice	1.5	4[10]	Lec	Ess	1,2
4.12	Acoustical branch of diatomic lattice	1	4[5]	Lec	Ess	1,2
4.13	In classic scattering by phonons	1	4[5]	Lec	Ess	1,2
V	**PHONONS II THERMAL PROPERTIES**					
5.1	Phonon heat capacity	1	5[10]	Lec	SA, Qui	1,2
5.2	Planck distribution	1	5[5]	Lec	Ess	1,2

5.3	Normal mode enumeration	0.5	5[5]	Lec	SA, MCQ	1,2
5.4	Density of states in one dimensions	0.5	5[5]	Lec	Ess	1,2
5.5	Density of states in three dimensions	1	5[10]	Lec	Ess	1,2
5.6	Dulong and Petits law – statement and explanation	1	5[10]	Lec	Ess	3
5.7	Classical Theory – Dulong and Petit's specific heat theory	1	5[5]	Lec	Ess	3
5.8	Einstein's theory of Specific heat	1	5[10]	Lec	Ess, Qse	3
5.9	Debey's theory of specific heat	1	5[10]	GD	SA	3
5.10	Anharmonic crystal interactions	1	5[5]	Lec	Ess	3
5.11	Thermal expansion.	0.5	5[5]	Lec	Ess	3
5.12	Thermal conductivity	0.5	5[5]	Lec	Ess	1,2
5.13	Thermal resistivity of phonon	1	5[5]	Lec	Ess	1,2
5.14	Umklapp Processes	1	5[5]	Lec	SA	1,2
5.15	Imperfections	1	5[5]	GD	SA	1,2

BOOKS FOR REFERENCE

1. Charles Kittel, Introduction to Solid State Physics, Wiley Eastern P. Ltd, Seventh Edition, 2000
2. S.O Pillai, Solid State Physics, Wiley Eastern Ltd., 1994
3. Dr. K. Ilangovan, Solid State Physics, MJP Publishers, Chennai, 2013.
4. J.P Srivastava, Elements of Solid State Physics, Prentice – Hall of India, New Delhi, 2004.
5. M. Arumugam, Solid State Physics, Anuradha Agencies, 2004
6. M. Ali Omar, Elementary Solid State Physics, Principles and Applications, Addition-Wesly series, 1993.
7. Solid State Physics, Bhima Shankaran, BS Publications, Hyderabad, 2002.

Course Title:	**MATHEMATICAL PHYSICS – II**	Course Type: **Theory**
		Course Code: **23PP22**
Total Hours: 9**0**	Hours/Week: **6**	Credits: **4**
Pass-Out Policy : Minimum Contact Hours: 54 Total Score %: **100** Internal: **40** External: **60** Minimum Pass %: **50** [No Minimum for Internal]		
Course Creator:	**Expert 1:**	**Expert 2:**
Prof. A. Charles Hepzy Roy	**Dr. B.S. Benila**	**Dr. S. Sharmila Juliet**
Asso. Prof., Faculty Head	Asso. Prof. of Physics	Assi. Prof. of Physics
+919944261881	**+919843626563**	**+919487094860**
achroy66@gmail.com	**benila@scottchristian.org**	**sharmilabennet@gmail.com**

CLO No.	**Expected Course Learning Outcome** *Upon completion of this course, the students will be able to:*	PLO % MAPPED WITH CLO	CLO & PLO MAPPED WITH GA	Cognitive Level CL	Knowledge Catogory KC
CLO- 1	Comprehend the application of mathematical concepts needed to solve problems in physics as well as other areas of science, and acquire practical skills in the use of these methods	**1[10] 6[10]**	**1,2,3, 5,6,8, 10**	**U, Ap, An**	**C, F**
CLO- 2	Distinguish groups and construct multiplication tables and utilize various representation theories of finite groups	**1[10] 6[10]**	**1,2,3, 5,6,8, 10**	**R, Ap, An, E**	**F, P**
CLO- 3	Formulate and express a physical law in terms of tensors, and simplify it by the use of coordinate transformations (example: Hooke's law, moment of Inertia)	**1[10] 6[10]**	**1,2,3, 5,6,8, 10**	**U, An, C**	**P, M**
CLO- 4	Identify second order linear differential equation and find the linear independent solutions. Elaborate the orthogonal polynomials and other special functions	**1[10] 6[10]**	**1,2,3, 5,6,8, 10**	**U, Ap, An, C**	**C, P**
CLO- 5	Apply integral transform (Fourier and Laplace) to solve mathematical problems of interest in physics	**1[10] 6[10]**	**1,2,3, 5,6,8, 10**	**U Ap, An**	**F, M**

Module	**Course Description**	**Hours**	**% CLO Mapping with Module**	**Learning Activitie**	**Assessment Tasks**	**Reference**
I	**ABSTRACT GROUP THEORY**					
1.1	Group – Definition, Abelian and Cyclic Groups	1	1[10]	Lec	SA, Pro	1
1.2	The Groups of Symmetry of an equilateral triangle	1	1[10]	GD	Ess	1
1.3	The Groups of Symmetry of a Square	1	1[5]	GD	Ess	1
1.4	Multiplication Table	1	1[5]	Lec, GD	SA, Pro	1
1.5	Generaors of Finite Group	1	1[5]	Lec	SA	1
1.6	Conjugate Elements and Classes	1	1[10]	Lec	Ess	1
1.7	Multiplication of Classes	1	1[10]	Lec	SA	1
1.8	Subgroups - Cosets	1	1[10]	Lec	SA	1
1.9	A Theorem on Subgroups	1	1[10]	Lec	Ess	1
1.10	Normal Subgroup and Factor Group	2	1[10]	Lec	SA	1
1.11	Isomorphism and Homomorphism	1	1[5]	Lec, GD	SA	1
1.12	Permutation Group	1	1[5]	Lec	SA	1
1.13	Direct Groups of Given Order	1	1[5]	Lec, GD	Ess	1

II	**REPRESENTATION THEORY OF FINITE GROUPS**					
2.1	Definition	0.5	2[10]	Lec	SA	1
2.2	Some Properties of Representation of Group	0.5	2[10]	Lec, GD	SA	1
2.3	Invariant Subgroup, Reducible and Irreducible Representation	1	2[10]	Lec	SA, Ess	1
2.4	Theorem 1:Theorem on Representation	1	2[5]	Lec	Ess, Ass	1
2.5	Theorem 2:Schur's Lemma	1	2[5]	Lec	Ess, Ass	1
2.6	Theorem 3:Lemma	1	2[10]	Lec	Ess, Ass	1
2.7	The Orthogonality Theroem	1	2[10]	Lec	Ess, Ass	1
2.8	Interpretation of Orthogonality Theroem	1	2[10]	Lec	Ess	1
2.9	Characters of Representation	1	2[10]	Lec	Ess	1
2.10	Reduction of Reducible Representation	1	2[5]	Lec	Ess	1
2.11	The character Table of C4v	1	2[5]	Lec	SA	1
2.12	Construction of Character Tables	1	2[5]	Lec, GD	Ess, Sem	1
2.13	Problems	1	2[5]	Lec, GD	Ess, Sem	1
III	**TENSOR ANALYSIS**					
3.1	Coordinate Transformation – Contravariant and Covariant Tensors	0.5	3[10]	Lec	SA, Ess	2
3.2	Algebra of Tensors – Equality and Null Tensors – Addition and Subtraction of Tensors	0.5	3[10]	Lec	SA	2
3.3	Outer Product and Inner Product of Tensors	0.5	3[5]	Lec, GD	SA, Pro	2
3.4	Contraction of a Tensor	0.5	3[5]	Lec	SA, Ess	2
3.5	Symmetric and Antisymmetric Tensors	1	3[5]	Lec	Ess	2
3.6	Invariant Tensors - Kronecker Delta and Levi Civita Symbol	1	3[5]	Lec	Ess, Ass	2
3.7	Quotient Law	1	3[10]	Lec	Ess	2
3.8	Conjugate Symmetric Tensor of Rank 2	1	3[10]	Lec	Ess	2
3.9	The Fundamental Tensor	0.5	3[10]	Lec	SA, Ess	2
3.10	Contravariant Metric Tensor	0.5	3[5]	Lec	Ess	2
3.11	Asso. Tensors – Raising and lowering of Indices	1	3[5]	Lec, GD	Ess, Ass	2
3.12	Cartesian Tensors	1	3[5]	Lec	Ess	2
3.13	Applications - Hooke's law	1	3[10]	Lec	Ess,Sem	2
3.14	-Moment of Inertia	1	3[5]	Lec	Ess, Sem	2
IV	**SPECIAL FUNCTIONS - II**					
4.1	Bessel differential equation – solution	1	4[10]	Lec	Ess	3
4.2	Bessel functions of first and second kind	1	4[10]	Lec	Ess	3
4.3	Generating function	1	4[5]	CL	Qui	3
4.4	Recurrence formula	1	4[5]	CL	Pro	3
4.5	Orthogonality of Bessel's function	1	4[10]	Sem	SA	3
4.6	Spherical Bessel function and its properties	1	4[10]	Lec	Ess	3

4.7	Hermite differential equation – solution	1	4[10]	Lec	Ess	3
4.8	Generating function	1	4[10]	GD	Pro	3
4.9	Rodrigue's formula	1	4[10]	Lec	SA,Pro	3
4.10	Recurrence Relation	1	4[10]	Lec	Ess	3
4.11	Orthogonality of Hermite polynomials	1	4[10]	Lec	Ess	3
V	**FOURIER AND LAPLACE INTEGRAL TRANSFORM**					
5.1	Fourier Series	1	5[10]	Lec	SA, Qui	3
5.2	Related Problems – Uses of Fourier Series	1	5[10]	GD	Pro	3
5.3	Fourier Transform – Properties.	1	5[10]	Lec	SA, Qui	3
5.4	Fourier Transform of a Derivative.	1	5[10]	Lec	SA	3
5.5	Fourier sine and cosine Transform of Derivatives.	1	5[10]	GD	SA	3
5.6	Laplace Transform – Properties.	1	5[5]	Lec	MCQ	3
5.7	Laplace Transform of Derivative of a Function.	1	5[10]	BS	SA	3
5.8	Laplace Transform of Integral.	1	5[5]	Lec	SA	3
5.9	Inverse Laplace Transform.	1	5[5]	GD	SA	3
5.10	Evaluation Methods: Convolution Theorem	1	5[5]	Lec	Pro	3
5.11	Partial Fraction Method	1	5[10]	Lec	Pro	3
5.12	Problems related to Fourier series, Fourier transform, Laplace transform and inverse Fourier transform	1	5[10]	GD	Ess, Pro	3

BOOKS FOR REFERENCE:

1. A.W. Joshi, Elements of Group Theory for Physicists, Third edition, Wiley Eastern Ltd., 1988.
2. A.W. Joshi, Matrices and Tensors in Physics; Second edition, Wiley Eastern Limited, 1985.
3. Satyaprakash, Mathematical Physics, S. Chand Company Ltd., New Delhi, 1994.
4. B.S. Rajput, Mathematical Physics, Pragati Prakashan Meerut, 2005

Course Title:	**ELECTRONICS & ADVANCED PHYSICS II**	Course Type: **Practical-II**
		Course Code: **23PPP2**
Total Hours: **90**	Hours/Week: **6**	Credits: **4**
Pass-Out Policy : Minimum Contact Hours: 54 Total Score %: **100**	Internal: **40**	External: **60**
Minimum Pass %: **50**	[No Minimum for Internal]	
Course Creator:	**Expert 1:**	**Expert 2:**
Prof. A. Charles Hepzy Roy	**Dr. C. Y. Premila Rachelin**	**Dr. S. Sharmila Juliet**
Asso. Prof., Faculty Head	Asso. Prof. of Physics	Assi. Prof. of Physics
+919944261881	**+919489620591**	**+919487094860**
achroy66@gmail.com	**premilarachelin@gmail.com**	**sharmilabennet@gmail.com**

CLO No.	**Expected Course Learning Outcome** *Upon completion of this course, the students will be able to:*	PLO % MAPPED WITH CLO	CLO & PLO MAPPED WITH GA	Cognitive Level CL	Knowledge Catogory KC
CLO-1	Improve the analytical and observation ability in Physics Experiments to determine any physical constant for materials;	**1[10] 6[10]**	**1,2,3, 5,6,8, 10**	**U, Ap, An**	**C, P**
CLO-2	Get an in-depth knowledge on designing electronic circuits;	**1[10] 6[10]**	**1,2,3, 5,6,8, 10**	**R, An, E**	**F, P**
CLO-3	Familiarize in extracting circuit parameters	**1[10] 6[10]**	**1,2,3, 5,6,8, 10**	**U, An, C**	**P, M**
CLO-4	The students will have a good foundation in the fundamentals related to the experiments included in this course and their advanced applications.	**1[10] 6[10]**	**1,2,3, 5,6,8, 10**	**U, Ap, An, C**	**C, P**
CLO-5	The students will be able to learn practically the interference and diffraction, thermocouple, Wheatstone bridge principles and Op-Amp.	**1[10] 6[10]**	**1,2,3, 5,6,8, 10**	**U Ap, An**	**F, M**

Sl.No	**Course Description**
1	Measurement of Susceptibility of liquid - Quinke's method
2	B-H Curve using CRO
3	Measurement of coefficient of linear expansion -Air Wedge method
4	Measurement of Magnetic Susceptibility -Guoy's method
5	Determination of Numerical Aperture and Acceptance angle of optical fiber using Laser source.
6	Hall effect in semiconductor. Determine the Hall coefficient, carrier concentration and carrier mobility.
7	Interpretation of vibrational spectra of a given material
8	Determination of Refractive index of liquid using diode laser/ He-Ne laser.
9	Determination of dielectric constant of solids.
10	Determination of lattice parameter from XRD pattern – cubic, tetragonal and hexagonal systems.
11	To study electron spin resonance (ESR) and to determine the g-factor of free electrons for a given specimen**.**
12	Determine the dielectric constant of a liquid by Lecher wire.
13	Find the dielectric constant of a given solid (Teflon) for three different lengths as

	functions of temperature.
14	Construction of square wave generator using IC 555 – Study of VCO
15	Construction of Schmitt trigger circuit using the IC 555 for a given hysteresis - Application as squarer
16	Solving simultaneous equations – IC 741 / IC LM324
17	Op-Amp – Butterworth Active Filters: Low pass and High pass
18	Analog to digital converter
19	BCD to Excess- 3 and Excess 3 to BCD code conversion
20	Arithmetic operations using IC 7483- 4-bit binary addition and subtraction.
21	Construction of Multiplexer and Demultiplexer using ICs.
22	Construction of Encoder and Decoder circuits using ICs
23	IC 7490 as scalar and seven segment display using IC7447
24	Shift register and Ring counter and Johnson counter- IC 7476/IC 7474
25	Study of synchronous parallel 4-bit binary up/down counter using IC 74193
26	Study of asynchronous parallel 4-bit binary up/down counter using IC 7493

BOOKS FOR REFERENCE

1. S.P. Singh, Advanced Practical Physics, Vol. I & II, Pragati Prakashan, New Delhi, 2001.
2. F. Tyler , A Lab Manual of Physics, Edward Arnold Publisher Ltd., 1970.
3. C.L. Arora, Practical Physics, S. Chand & Co., New Delhi, 2001
4. K.A. Navas, Electronics Laboratory Manual, vol. I, IV Ed., Rajath Publisher, Ernakulam
5. Navas, Elevtronic Laboratory Manual, vol. II., IV Ed., Rajath Publisher, Ernakulam
6. J.D. Karyachen, S. Shyam Mohan, Electronics Lab Manual, vol. II, Ayodhaya Publication II Ed., Kottayam, 2011
7. Kar, Advanced Practical Electronics, Books and Allied (P) Ltd, Kolkatta, 2010

Course Title: **ARDUINO HARDWARE & PROGRAMMING**		Course Type: **Theory**
		Course Code: **23PPEB**
Total Hours: **90**	Hours/Week: **6**	Credits: **4**
Pass-Out Policy : Minimum Contact Hours: 54 Total Score %: **100** Internal: **40** External: **60** Minimum Pass %: **50** [No Minimum for Internal]		
Course Creator:	**Expert 1:**	**Expert 2:**
Prof. A. Charles Hepzy Roy	**Dr. C. James**	**Dr. S. Sharmila Juliet**
Asso. Prof., Faculty Head	Asso. Prof. of Physics	Assi. Prof. of Physics
+919944261881	**+919489500237**	**+919487094860**
achroy66@gmail.com	**james@scottchristian.org**	**sharmilabennet@gmail.com**

CLO-No.	Expected Course Learning Outcome *Upon completion of this course, the students will be able to ….*	PLO % MAPPED WITH CLO	CLO & PLO MAPPED WITH GA	Cognitive Level CL	Knowledge Catogory KC
CLO-1	describe the functions of various hardware components of Arduino board and work with open-source Arduino Software Integrated Development Environment (IDE). illustrate various Arduino Programming Structures.	**6[10] 10[10]**	**1,2,3, 5,7,9, 10**	**U, Ap**	**C, P**
CLO-2	infer different Arduino Function libraries to be used with sketch	**6[10] 10[10]**	**1,2,3, 5,7,9, 10**	**R, An**	**F, P**
CLO-3	formulate communication with peripherals through parallel and serial ports of Arduino.	**6[10] 10[10]**	**1,2,3, 5,7,9, 10**	**An C**	**P**
CLO-4	devise Arduino Communication with external world using sensors, and actuators.	**6[10] 10[10]**	**1,2,3, 5,7,9, 10**	**R, An E**	**P, M**
CLO-5	design circuits and write code for developing Arduino prototypes.	**6[10] 10[10]**	**1,2,3, 5,7,9, 10**	**U Ap An**	**M**

Module	Course Description	Hours	% CLO Mapping with Module	Learning Activitie	Assessment Tasks	Reference
I	**ARDUINO ENVIRONMENT**					
1.1	Arduino overview	1	1[10]	Lec	MCQ	1
1.2	Arduino Board Description	1	1[10]	BS	Qui	1
1.3	Main components, inputs, and outputs	1	1[10]	TPS	Ass	1
1.4	ATMEL Microcontroller	1	1 [10]	OO	Qui	1
1.5	Arduino IDE	1	1 [5]	Lec	Ass	1
1.6	Arduino Programme Structure	1	1 [10]	GD	Ass	1
1.7	Arduino Data Types	1	1 [10]	PT	MCQ	2
1.8	Arduino – Variables & Constants	1	1 [10]	GT	Qui	2
1.9	Arduino – Operators	1	1 [5]	BS	Qui	2
1.10	Arduino – Control Statements	1	1 [10]	GD	Ass	2
1.11	Arduino – Loops	2	1 [10]	SM	SA	2
II	**ARDUINO FUNCTION LIBRARIES WITH SKETCH**					
2.1	Arduino – Functions	1	2[10]	Lec	MCQ	2

2.2	Arduino – Strings	2	2[10]	PT	Qui	2
2.3	Arduino – String Object	1	2[10]	GT	Ass	2
2.4	Arduino – Time	1	2[10]	TPS	Ass	2
2.5	Arduino – Arrays	2	2[10]	SI	SA	2
2.6	Arduino – I/O Functions	1	2[10]	BS	Qui	2
2.7	Arduino – Advanced I/O Function	1	2[10]	Lec	SA	2
2.8	Arduino – Character Functions	1	2[10]	TPS	Ass	2
2.9	Arduino – Math Library	1	2[10]	GT	MCQ	2
2.10	Arduino – Trigonometric Functions	1	2[10]	BS	Qui	2
III	**ARDUINO COMMUNICATION**					
3.1	Arduino Pulse Width Modulation	1	3[10]	Lec	Ass	2
3.2	Arduino Random Numbers	1	3[10]	BS	Qui	2
3.3	Arduino Interrupts	1	3[10]	TPS	Ass	2
3.4	Arduino Serial & Parallel Communication	1	3[15]	GD	Ass	2
3.5	Arduino Inter Integrated Circuit	1	3[10]	PT	MCQ	2
3.6	Arduino Serial Peripheral Interface	1	3[15]	PT	Qui	2
3.7	Arduino Tone Library	2	3[10]	OO	Ass	2
3.8	Arduino Wireless Communication	2	3[10]	GT	Qui	2
3.9	Arduino Network Communication	2	3[10]	SI	SA	2
IV	**INTERFACING SENSORS AND ACTUATORS**					
4.1	Arduino Humidity Sensor	1	4[10]	Lec	Qui	2
4.2	Arduino Temperature Sensor	1	4[10]	SM	MCQ	2
4.3	Arduino Water Detector Sensor	1	4[10]	BS	Ass	2
4.4	Arduino PIR Sensor	1	4[10]	TPS	Ass	2
4.5	Arduino Ultrasonic Sensor	1	4[15]	GD	SA	2
4.6	Arduino Connecting Switch	1	4[10]	BS	SA	2
4.7	Arduino DC Motor – Speed & Direction	2	4[15]	PT	Qui	2
4.8	Arduino Servo Motor	2	4[10]	GD	Ass	2
4.9	Arduino Stepper Motor	2	4[10]	TPS	SA	2
V	**ARDUINO PROTOTYPING**					
5.1	Arduino Blinking and Fading LED	1	5[10]	CL	Qui	2
5.2	Arduino Reading Analog Voltage	1	5[10]	EL	Ass	3
5.3	Arduino Measurement of Capacitance	1	5[10]	EL	Sem	3
5.4	Arduino Measurement of Light (lux meter)	1	5[10]	EL	Sem	3
5.5	Arduino Measurement of Pressure	1	5[10]	EL	SA	3
5.6	Arduino Traffic Light	1	5[5]	GT	MPr	4
5.7	Arduino Night Security Light	1	5[10]	OO	MCQ	4
5.8	Arduino SONAR	2	5[10]	GD	Ess	4
5.9	Arduino Water Irrigation System	1	5[10]	TPS	MPr	4
5.10	Arduino Time Attendance System	1	5[10]	BS	Ess	4
5.11	Arduino Gas Leakage Detector	1	5[5]	GT	Ess	3

BOOKS FOR REFERENCE

1. John Nussey, Arduino for Dummies – 2nd Edition, John Wiley & Sons, Inc, New Jersey, 2018.
2. Turorialspoint.com, *Arduino.* Tutorials Point (I) Pvt. Ltd, Hyderabad, 2016.
3. Simone Bales, *Arduino Measurement Projects for beginners*, STEMedu, Brussels, 2020.
4. Rui Santos, *Arduino Arduino Projects– 2nd Edition*, Random Nerd Tutorials.com, Porto, 2020.
5. Simon Monk, *Programming Arduino – Getting Started with Sketches*, Mc Graw Hill, New York, 2012.
6. Brian W. Evans, *Arduino Programming Notebook*, Creative Commons, San Francisco, 2008.

Course Title:	**MATERIAL SCIENCE**	Course Type: **Theory**
		Course Code: **23PPN1**
Total Hours: **90**	Hours/Week: **6**	Credits: **4**
Pass-Out Policy : Minimum Contact Hours: 54 Total Score %: **100** Internal: **40** External: **60** Minimum Pass %: **50** [No Minimum for Internal]		
Course Creator:	**Expert 1:**	**Expert 2:**
Prof. A. Charles Hepzy Roy	**Dr. A. Hudson Oliver**	**Dr. H. Adlin Mahiba**
Asso. Prof., Faculty Head	Assi. Prof. of Physics	Assi. Prof. of Physics
+919944261881	**+919952654515**	**+919486578077**
achroy66@gmail.com	**hudson2612@gmail.com**	**adlinemahiba1@gmail.com**

CLO-No.	**Course Learning Outcome** ***Upon completion of this course, students will be able to:***	**PLO % MAPPED WITH CLO**	**CLO & PLO MAPPED WITH GA**	**Cognitive Level CL**	**Knowledge Catogory KC**
CLO- 1	Acquire knowledge on optoelectronic materials	**3[10] 4[10]**	**1,2,3, 5,6,7, 9**	**R**	**F, C**
CLO- 2	Be able to prepare ceramic materials	**3[10] 4[10]**	**1,2,3, 5,6,7, 9**	**Ap**	**C, P**
CLO- 3	Be able to understand the processing and applications of polymeric materials	**3[10] 4[10]**	**1,2,3, 5,6,7, 9**	**U Ap**	**P**
CLO- 4	Be aware of the fabrication of composite materials	**3[10] 4[10]**	**1,2,3, 5,6,7, 9**	**E**	**P, M**

CLO- 5	Be knowledgeable of shape memory alloys, metallic glasses and nanomaterials.	**3[10] 4[10]**	**1,2,3, 5,6,7, 9**	**R**	**F, M**

Module	Course Description	Hours	% CLO Mapping with Module	Learning Activitie	Assessment Tasks	Reference
I	**OPTOELECTRONIC MATERIALS**					
1.1	Importance of optical materials – properties	1	1[10]	Lec	SA	1
1.2	Light interactions with solids	1	1[10]	Lec	SA	1
1.3	Band structure, energy levels, Band gap and lattice matching	2	1[15]	GD	MCQ	1
1.4	Optical Properties of materials - Absorption, reflection, transmission and other properties	2	1[15]	Lec	SA	1
1.5	Optical processes in quantum structures	1	1[10]	GD	Ess	1
1.6	Organic semiconductors	1	1[10]	Lec	Ess	1
1.7	Light propagation in materials – Electro-optic effect and modulation	2	1[15]	Lec	Ess	1
1.8	Optoelectronic Devices – LED, Photodiode, Solar cell	2	1[15]	Lec	SA	1
II	**CERAMIC MATERIALS**					
2.1	Ceramic processing	1	2[15]	Lec	Ess	2,5
2.2	Powder processing	2	2[15]	Lec	Ess	2,5
2.3	Milling and sintering	2	2[15]	Lec	SA	2,5
2.4	Traditional ceramics	1	2[10]	GD	MCQ	2,5
2.5	Structural ceramics	1	2[10]	GD	SA	2,5
2.6	Mechanical properties of ceramics	2	2[15]	GD	SA	2,5
2.7	Refractories	1	2[10]	Lec	SA	2,5
2.8	Glass and glass ceramics	2	2[10]	Lec	SA	2,5
III	**POLYMERIC MATERIALS**					

3.1	Polymeric Materials – introduction and classification	1	3[10]	Lec	Ess	2,5
3.2	Molecular structure of polymers	1	3[10]	Lec	Ess	2,5
3.3	Polymerization techniques	1	3[10]	Lec	Ess	2,5
3.4	Mechanical Properties of Polymers - Elasticity, viscosity, rheology, Thermal Stability and degradation	2	3[15]	GD	Ass	2,5
3.5	Polymer Processing Techniques	2	3[10]	GD	SA	2,5
3.6	Copolymers	1	3[10]	GD	SA	2,5
3.7	Applications: conducting polymers	2	3[15]	Lec	Ass	2,5
3.8	Biopolymers	1	3[10]	Lec	Ass	2,5
3.9	High temperature polymers	1	3[10]	Lec	Ess	2,5
IV	**COMPOSITE MATERIALS**					
4.1	Particle reinforced composites	1	4[15]	Lec	Sem	2,4
4.2	Fiber reinforced composites	2	4[15]	Lec	Sem	2,4
4.3	Mechanical behavior	1	4[10]	GD	Sem	2,4
4.4	polymer matrix composites	2	4[15]	Lec	Ass	2,4
4.5	metal matrix composites	2	4[15]	Lec	Ass	2,4
4.6	Carbon/carbon composites	2	4[10]	Lec	SA	2,4
4.7	Nanocomposites	1	4[10]	Lec	Sem	2,4
4.8	Applications	1	4[10]	GD	Sem	2,4
V	**NEW MATERIALS**					
5.1	Shape memory alloys	1	5[10]	Lec	Sem	3,4
5.2	Mechanisms of one-way and two-way shape memory effect	1	5[10]	Lec	Ess	3,4
5.3	Thermo-elasticity and pseudo-elasticity Examples and applications	2	5[15]	Lec	SA	3,4

5.4	Superconducting materials and piezoelectric materials	1	5[10]	GD	MCQ	3,4
5.5	Amorphous Metals	2	5[10]	GD	Sem	3,4
5.6	Nanomaterials: classification	1	5[10]	Lec	Ass	3,4
5.7	Size effect on structural and functional properties	1	5[10]	Lec	Ass	3,4
5.8	Processing and properties of Nano crystalline materials	1	5[10]	GD	Sem	3,4
5.9	Materials of Importance—Biodegradable and Bio-renewable Polymers/Plastics	2	5[15]	Lec	Sem	3,4

BOOKS FOR REFERENCE:

1. Jasprit Singh, Electronic and optoelectronic properties of semiconductor structures, Cambridge University Press, 2007.
2. William D. Callister, David G. Rethwisch, Materials science and engineering : an introduction, 10th edition, John Wiley & Sons
3. William F. Smith, Javad Hashemi, 6th Edition, Foundations of Materials Science and Engineering, McGraw-Hill Education
4. V. Raghavan, 2003, Materials Science and Engineering, 4th Edition, Prentice- Hall India, New Delhi.
5. G.K. Narula, K.S. Narula and V.K. Gupta, 1988, Materials Science, Tata McGraw-Hill
6. https://onlinecourses.nptel.ac.in/noc20_mm02/preview
7. https://nptel.ac.in/courses/112104229
8. https://archive.nptel.ac.in/courses/113/105/113105081
9. https://nptel.ac.in/courses/113/105/113105025/
10. https://eng.libretexts.org/Bookshelves/Materials_Science/Supplemental_Modules_(Materials_Science)/Electronic_Properties/Lattice_Vibrations

SEMESTER III

Course Title: **QUANTUM MECHANICS**		Course Type: **Theory**
		Course Code: **23PP31**
Total Hours: **90**	Hours/Week: **6**	Credits: **4**
Pass-Out Policy : Minimum Contact Hours: 54		
Total Score %: **100**	Internal: **40**	External: **60**
Minimum Pass %: **50**	[No Minimum for Internal]	

Course Creator:	Expert 1:	Expert 2:
Prof. A. Charles Hepzy Roy	Dr. S. Sharmila Juliet	Dr. D.J. Jeejamol
Asso. Prof., Faculty Head	Assi. Prof. of Physics	Assi. Prof. of Physics
+919944261881	+919487094860	+917598629087
achroy66@gmail.com	sharmilabennet@gmail.com	lomajeej@gmail.com

CLO-No.	Course Learning Outcome *Upon completion of this course, students will be able to:*	PLO % MAPPED WITH CLO	LO & PLO MAPPED WITH GA	Cognitive Level CL	nowledge Catogory KC
CLO-1	Know the background and the main features of quantum mechanics and discuss the uncertainty relation.	1[10] 2[10]	1,2,3, 6,8	R, U	C
CLO-2	Gain understanding on historical importance of Bohr's model of the hydrogen atom, its strengths and weaknesses, and how it differs from the	1[10] 2[10]	1,2,3, 6,8	U, Ap	F
CLO-3	Develop a knowledge and understanding of the role of angular momentum in atomic and nuclear physics;	1[10] 2[10]	1,2,3, 6,8	An	P
CLO-4	Expand knowledge and understanding of perturbation theory, level splitting, and radioactive transitions and Explain the Stark affect and spin orbit coupling.	1[10] 2[10]	1,2,3, 6,8	An, E	P, M
CLO-5	Use relativistic wave equations for the description of particles travelling at speeds close to that of light	1[10] 2[10]	1,2,3, 6,8	E, C	F, M

Module	Course Description	Hours	% CLO Mapping with Module	Learning Activitie	Assessment Tasks	Reference
I	GENERAL FORMALISM OF WAVE MECHANICS					
1.1	Inadequacy of classical mechanics	1	1[10]	Lec	SA	1
1.2	The Schrodinger equation and the probability for N-particle system	1	1[10]	Lec	Ess	1
1.3	The fundamental postulates of wave mechanics	1	1[10]	Lec, GD	SA, Ess	1
1.4	The adjoint of an operator and self adjointness	1	1[5]	Lec	SA, Ess	1
1.5	The Eigenvalue problem; degeneracy	1	1[5]	Lec	SA	1
1.6	Eigenvalues and Eigenfunction of self adjoint operators.	1	1[5]	Lec	SA, Ess	1
1.7	The dirac delta function	1	1[5]	Lec	SA	1
1.8	Observables; completeness and normalization of Eigenfunctions	1	1[10]	Lec	SA	1
1.9	Closure property	1	1[10]	Lec,	Ess	1

				GD		
1.10	Physical interpretation of Eigenvalues, Eigenfunctions and expansion coefficient	1	1[10]	Lec	SA, Ess	1
1.11	The uncertainty principle – statement and proof	1	1[10]	Lec, GD	Ess, Sem	1
1.12	Ehrenfest theorem	1	1[10]	Lec' GD	Ess, Sem	1
II	**EXACTLY SOLVABLE EIGENVALUE PROBLEM**					
2.1	Simple harmonic oscillator	1	2[10]	Lec	Pro	1
2.2	The Schrodinger equation and energy Eigenvalues	1	2[10]	Lec	Ess, Ass	1
2.3	The energy Eigenfunctions	1	2[5]	Lec	SA	1
2.4	Series solution – asymptotic behaviour	1	2[10]	Lec, GD	Ess	1
2.5	Orthonormality	1	2[10]	Lec	Ess	1
2.6	Properties of stationary states	1	2[5]	Lec	SA	1
2.7	Hydrogen atom	1	2[10]	Lec	Pro	1
2.8	Solution of the radial equation	1	2[10]	Lec, GD	Ess, Sem	1
2.9	Angular part energy levels	1	2[5]	Lec, GD	Ess, Sem	1
2.10	Stationary state wave functions	1	2[10]	Lec	Ess	1
2.11	Discussion of bound states	1	2[5]	Lec	Ess	1
2.12	Square potential barrier	2	2[5]	Lec	Pro	1
2.13	Expressions for R and T	2	2[5]	Lec, GD	Ess, Ass	1
III	**ANGULAR MOMENTUM**					
3.1	The angular momentum operators	1	3[10]	Lec	SA	1
3.2	Angular momentum (L) in spherical co-ordinates	1	3[10]	Lec	SA	1
3.3	L^2 in spherical co-ordinates	1.5	3[10]	PT	SA	1
3.4	The Eigenvalue equation for L^2.	1.5	3[10]	Lec	Ess	1
3.5	Eigenvalues and Eigenfunctions	1	3[10]	Lec	Ess	1
3.6	Eigenvalue spectrum of J	1.5	3[10]	Lec	Ess	1
3.7	Matrix representation of <Jin/jm> basis	1.5	3[10]	Lec	Pro	1
3.8	Pauli's spin matrices	1	3[10]	PT	SA	1
3.9	Addition of angular momentum	1	3[10]	Lec	Pro	1
3.10	CG. Coefficients	1	3[10]	Lec	Pro	1
IV	**PERTURBATION THEORY FOR TIME EVOLUTION PROBLEMS**					
4.1	Perturbation theory for discrete levels	1	4[10]	Lec	Ess	1
4.2	Perturbation solutions for Transition amplitude	1	4[10]	Lec	Ess	1
4.3	Selection rules	1	4[10]	Lec	Ess	1
4.4	First order transitions: constant perturbation – Transition probability	1	4[10]	Lec	Ess	1
4.5	Second Order transitions; constant perturbation , Rate of Transition	1	4[5]	SI	Pro	1
4.6	Scattering of a particle by a potential	2	4[10]	Lec	Ess	1

4.7	The effect of an electric field on the 4.8 energy levels of an atom (Stark effect)	1.5	4[10]	SI	Pro	1
4.8	Interaction of an atom with electromagnetic radiation	0.5	4[5]	Lec	Ess	1
4.9	The dipole approximation	1	4[10]	PT	Ess	1
4.10	Selection rules; allowed and forbidden Transition	1	4[10]	Lec	Ess	1
4.11	The Einstein coefficients; spontaneous emission	2	4[10]	SI	Pro	1
V	**RELATIVISTIC QUANTUM MECHANICS**					
5.1	Generalization of the Schrödinger Equation - The Klein-Gordon Equation	1	5[10]	Lec	Ess	1, 2
5.2	Plane Wave Solutions; Charge and Current Densities	1	5[10]	Lec	Ess, Ass	1, 2
5.3	Interaction with Electromagnetic Fields; Hydrogen-like Atom	1	5[10]	Lec	Ess, Ass	1, 2
5.4	Nonrelativistic Limit	1	5[10]	Lec	Ess, Ass	1, 2
5.5	The Dirac Equation - Dirac"s Relativistic Hamiltonian	1	5[5]	Lec	SA,	1, 2
5.6	Position Probability Density; Expectation Values	2	5[10]	Lec, GD	SA, Pro	1, 2
5.7	Dirac Matrices	1	5[10]	Lec	Ess	1, 2
5.8	Plane Wave Solutions of the Dirac Equation; Energy Spectrum	2	5[10]	Lec	Ess	1, 2
5.9	The Spin of the Dirac Particle	1	5[10]	Lec	Ess	1, 2
5.10	Significance of Negative Energy States; Dirac Particle in Electromagnetic Fields	1	5[10]	Lec	Ess	1, 2
5.11	The Spin Orbit Energy	1	5[5]	Lec	Ess, Sem	1, 2

BOOKS FOR REFERENCE:

1. G. Aruldhas, A Text book of Quantum Mechanics, Prentice Hall of India Pvt., Ltd.,2002
2. Satya Prakash, Quantum Mechanics, Kedar Nath Ram Nath and Co. Publications,2018.
3. P.M. Mathews and K. Venkatesan, A Text Book of Quantum Mechanics, Tata McGraw Hill Publications, Second edition, 2010.
4. A. K. Ghatak and Lokanathan, Quantum Mechanics, Theory and applications, Macmillan India Ltd Publication, Fifth Edition, 2015.
5. Leonard I. Schiff, Quantum Mechanics, McGraw-Hill International Publication, Third Edition, 1968.
6. V. K. Thankappan, Quantum Mechanics, New Age International (P) Ltd. Publication, Second Edition, 2003.

7. E. Merzbacher, Quantum Mechanics, John Wiley Interscience Publications, ThirdEdition, 2011.
8. Claude Cohen-Tannoudji, Bernard Diu, Franck Laloë, Quantum Mechanics (Vol .I) - JohnWiley Interscience Publications, First Edition, 1991.
9. Pauling & Wilson, Quantum Mechanics, Dover Publications, New Edition, 1985.
10. R. Shankar, Principle of Quantum Mechanics, Plenum US Publication, SecondEdition, 1994.
11. L. Schiff, Quantum Mechanics, McGraw-Hill Book Co., New York, 1996.
12. S. Devarnathan, Quantum Mechanics, Narosa Publications (India) Pvt, Ltd., Chennai, 2004.
13. Kakani S.L and Chandalia H.M., Quantum Mechanics, Sultan Chand & Sons, New Delhi, 1994.
14. E. Merzbacher, Quantum Mechanics, Wiley International, New york, 1970.
15. V.K. Thankappan, Quantum Mechanics, Wiley-Eastern Ltd, 1993.

Course Title:	**ELECTROMAGNETIC THEORY**	Course Type: **Theory**
		Course Code: **23PP32**
Total Hours: **90**	Hours/Week: **6**	Credits: **4**
Pass-Out Policy : Minimum Contact Hours: 54 Total Score %: **100** Internal: **40** External: **60** Minimum Pass %: **50** [No Minimum for Internal]		
Course Creator:	**Expert 1:**	**Expert 2:**
Prof. A. Charles Hepzy Roy	**Dr. Y. Premila Rachelin**	**Dr. H. Adlin Mahiba**
Asso. Prof., Faculty Head	Asso. Prof. of Physics	Assi. Prof. of Physics
+919944261881	**+919489620591**	**+919486578077**
achroy66@gmail.com	**premilarachelin@gmail.com**	adlinemahiba1@gmail.com

CLO-No.	**Expected Course Learning Outcome Upon completion of this course, the students will be able to:**	**PLO % MAPPED WITH CLO**	**CLO & PLO MAPPED WITH GA**	**Cognitive Level CL**	**Knowledge Category KC**
CLO - 1	Formulate potential problems within electrostatics, magnetostatics and stationary current distributions in linear, isotropic media etc.	**1[10] 3[10]**	**1,2,3,5, 6,8**	**Ap**	**C**
CLO - 2	Define and derive expressions for the energy both for the electrostatic and magnetostatic fields, and derive Poynting's theorem from Maxwell's equations and interpretthe terms in the theorem physically.	**1[10] 3[10]**	**1,2,3,5, 6,8**	**An**	**F**
CLO - 3	describe, qualitatively, the effects of moving a conductor in an external magnetic field, in terms of moving charges in a magnetic field	**1[10] 3[10]**	**1,2,3,5, 6,8**	**Ap**	**P**

CLO - 4	Describe and make calculations of plane electromagnetic waves in homogeneous media, including reflection of such waves in plane boundaries between homogeneous media.	**1[10] 3[10]**	**1,2,3,5, 6,8**	**E**	**C, P**
CLO - 5	Understand charged particles and fluids interacting with self-consistent electric and magnetic fields.	**1[10] 3[10]**	**1,2,3,5, 6,8**	**U**	**F, M**

Module	**Course Description**	**Hours**	**% CLO Mapping with Module**	**Learning Activitie**	**Assessment Tasks**	**Reference**
I	**ELECTROSTATICS**					
1.1	Electric field – coulombs law	0.5	1[5]	BS	Quiz	1
1.2	Continuous charge distribution	0.5	1[5]	TPS	Ass.	1
1.3	Gauss – law – application	1	1[10]	Lec	Ess	1
1.4	Divergence of E, Curl of E	1	1[5]	BS	SA	1
1.5	Electric potentials, Poisson's, Laplace equation	1	1[5]	Lec	SA	1
1.6	Potential of a localized charge distribution	1	1[10]	Lec	Ess	1
1.7	Electrostatic boundary condition	1	1[5]	Lec	Ess	1
1.8	Work and energy in electrostatics	1	1[5]	PT	SA	1
1.9	Energy – point charge, continuous charge	1	1[10]	TPS	SA	1
1.10	Laplace's equation – 2D – 3D	1	1[10]	Lec	Ess	1
1.11	Boundary condition. Uniqueness theorem	1	1[10]	Lec	Ess	1
1.12	Separation of variables – Cartesian – spherical	1	1[10]	Lec	Ess	1
1.13	Multipole expansion – monopole, dipole	1	1[10]	GT	Ess	1
II	**MAGNETOSTATICS**					
2.1	Magnetic field, magnetic force,	1	2[5]	GD	SA	1
2.2	Currents surface – volume, current density	1	2[5]	GT	Ass	1
2.3	Steady current – magnetic field of steady current	1	2[10]	Lec	SA	1
2.4	Divergence and Curl of B	1	2[10]	Lec	SA	1
2.5	Ampere's law – applications	2	2[10]	Lec	Ess	1
2.6	Comparison of electrostatics magneto statics	1	2[10]	GD	SA	1
2.7	Magnetic vector potential – spherical shell	2	2[20]	Lec	Ess	1
2.8	Effect of magnetic fields on atomic orbitals	1	2[10]	Lec	Ess	1

2.9	Ampere's Law in magnetized materials	1	2[10]	Lec	SA	1
2.10	Ferromagnetism.	1	2[10]	Lec	Ess	1
III	**ELECTROMOTIVE FORCE**					
3.1	Electromotive force – ohms law – motional emf	2	2[5]	GT	Quiz	1
3.2	Electromagnetic induction – Faraday's law	1	2[5]	GD	SA	1
3.3	Inductance – Neumann formula	1	2[10]	Lec	SA	1
3.4	Energy in magnetic field	1	2[10]	Lec	Ess	1
3.5	Maxwell's equation – Differential and integral form	1	2[10]	GD	Quiz	1
3.6	Maxwell's equation in matter	1	2[10]	Lec	Ess	1
3.7	Maxwell's equation in free space and linear isotrophic media	1	2[10]	Lec	Ess	1
3.8	Boundary conditions	1	2[10]	TPS	SA	1
3.9	Continuity equation – Poynting theorem	2	2[20]	Lec	Ess	1
3.10	Maxwell's stress tensor	1	2[10]	Lec	Ess	1
IV	**ELECTROMAGNETIC WAVES**					
4.1	Waves in one dimension	1	4[10]	BS	Ass	1
4.2	Wave equation -Sinusoidal waves	1	4[5]	TPS	SA	1
4.3	Boundary condition, reflection and transmission	1.5	4[10]	Lec	Ess	1
4.4	Wave equation for E & B.	1	4[5]	GT	Quiz	1
4.5	Monochromatic plane wave	0.5	4[5]	GD	Ass	1
4.6	Energy and momentum in EM waves	1	4[10]	OO	SA	1
4.7	Electromagnetic wave in matter	1	4[10]	Lec	Ess	1
4.8	Reflection, transmission, normal incidence	2	4[15]	Lec	Ess	1
4.9	Electromagnetic waves in conductors	1	4[10]	Lec	Ess	1
4.10	Reflection at a conducting surface	1	4[10]	GD	Ess	1
4.11	Wave guides, TE, TM, TEM, rectangular wave guides	1	4[10]	TPS	Ess	1
V	**APPLICATION OF ELECTROMAGNETIC WAVES**					
5.1	Boundary conditions at the surface of discontinuity	1	4[10]	Lec	SA	1
5.2	Reflection and refraction of E.M waves at the interface of non – Conducting media	2	4[15]	Lec	Ess	1

5.3	Kinematic and dynamic properties	1	4[10]	GD	Sem	1
5.4	Oblique incidence-Fresnel's equation	1	4[15]	Lec	Ess	1
5.5	Electric field vector 'E' parallel to the plane of incidence and perpendicular to the plane of	2	4[10]	Lec	Ess	1
5.6	Reflection and transmission co-efficients at the interface between two non–Conducting media –	2	4[15]	Lec	Ess	1
5.7	Brewster's law and degree of polarization	2	4[10]	Lec	SA	1
5.8	Total internal reflection.	1	4[15]	BS	Ess	1

BOOKS FOR REFERENCE

1. David. J. Griffiths, Introduction to Electrodynamics (Third Edition), Prentice Hall of India Edition, 2000.
2. B.S. Saxena, P.N. Saxena & R,.C. Gupta, Fundamentals of Solid State Physics, Pragathi Prakasan Publication, 1978.
3. John David Jackson, Classical Electrodynamics, Third Edition – John Wiley publications, 1999.
4. John R. Reitz, Frederick J. Millford, Robert W. Christy, Foundations of Electromagnetic Theory, Third Edition, Narosa publication house, 1988.

Course Title:	**MOLECULAR SPECTROSCOPY**	Course Type: **Theory**
		Course Code: **23PP33**
Total Hours: **90**	Hours/Week: **5**	Credits: **4**
Pass-Out Policy : Minimum Contact Hours: 54 Total Score %: **100**	Internal: **40**	External: **60**
Minimum Pass %: **50**	[No Minimum for Internal]	
Course Creator:	**Expert 1:**	**Expert 2:**
Prof. A. Charles Hepzy Roy	**Dr. C. Besky Job**	**Dr. Y. Sheeba Sherlin**
Asso. Prof., Faculty Head	Asso. Prof. of Physics	Asso. Prof. of Physics
+919944261881	**+919487026024**	**+919442304397**
achroy66@gmail.com	**cbjob1969@gmail.com**	**ysheebamohan@gmail.com**

CLO - No.	**Course Learning Outcome** ***Upon completion of this course, students will be able to:***	**PLO % MAPPED WITH CLO**	**LO & PLO MAPPED WITH GA**	**Cognitive Level CL**	**Knowledge Catogory KC**
CLO-1	Acquired knowledge and insight into the interaction of light with matter and the different optical responses	**4[10] 9[10]**	**1,2,6, 7,8,9**	**R, U**	**C**

CLO-2	Developed skills to interpret spectroscopic measurements and apply this information to clarify molecular structure and properties.	**4[10] 9[10]**	**1,2,6, 7,8,9**	**U, Ap**	**F**
CLO-3	Understood molecular interactions in Raman spectroscopic methods	**4[10] 9[10]**	**1,2,6, 7,8,9**	**An**	**P**
CLO-4	Attained knowledge to spectrometers by NMR and ESR theories	**4[10] 9[10]**	**1,2,6, 7,8,9**	**An, E**	**M**
CLO-5	Learned advanced surface spectroscopies (EELS, RAIRS, SERS, XPES, PES, and AES)	**4[10] 9[10]**	**1,2,6, 7,8,9**	**E, C**	**P, M**

Module	**Course Description**	**Hours**	**% CLO Mapping with Module**	**Learning Activitie**	**Assessment Tasks**	**Reference**
I	**INTRODUCTION AND MICROWAVE SPECTROSCOPY**					
1.1	Characterisation of electromagnetic radiation	1	1[5]	Lec	Qui	1
1.2	Quantization of energy	1	1[5]	Lec	Qui	1
1.3	Regions of spectrum	1	1[5]	GD	Qui	1
1.4	Fourier Transform Spectroscopy	1	1[10]	Lec	Ess	1
1.5	Classification of molecules	1	1[10]	GD	Qui	1
1.6	Rotational Spectra of rigid diatomic molecules	1	1[10]	Lec	Ess	1
1.7	Intensity of spectral lines	1	1[10]	Lec	SA	1
1.8	The spectrum of non- rigid rotator	1	1[10]	Lec	Ess	1
1.9	Rotational Spectra of polyatomic molecules	1	1[10]	Lec	Ess	1
1.10	Microwave Spectrometer	1	1[10]	Lec	SA	1
1.11	Chemical Analysis by microwave spectroscopy	1	1[10]	Lec	SA	1
1.12	Microwave oven	1	1[5]	OO	Qui	1
II	**INFRARED SPECTROSCOPY**					
2.1	Introduction	0.5	2[5]	GD	Qui	1
2.2	Simple harmonic osillator	1	2[5]	GD	SA	1
2.3	Anharmonic oscillator	1	2[5]	PT	SA	1
2.4	Diatomic vibrating rotator	1	2[10]	Lec	Ess	1

2.5	Fundamental vibrations and their symmetry	1	2[10]	Lec	SA	2
2.6	Influence of rotation on the spectra of polyatomic molecules	1	2[10]	Lec	Ess	1
2.7	Group Frequencies	1	2[5]	GD	Qui	2
2.8	Techniques and instrumentation	1	2[10]	Lec	SA	1
2.9	Pressed pellet technique, mull technique and ATR	1	2[10]	Lec	Ess	1
2.10	IR spectrum – Interpretation of organic compounds	1	2[10]	Lec	Ess	2
2.11	Finger print region	0.5	2[5]	Lec	SA	2
2.12	Carbon dioxide laser	1	2[5]	Lec	Qui	2
2.13	Factors affecting IR & RAMAN	1	2[10]	GD	SA	1
III	**RAMAN SPECTROSCOPY**					
3.1	Classical theory of Raman scattering	1	3[10]	Lec	SA	1
3.2	Quantum theory of Raman scattering	1	3[5]	GD	SA	1
3.3	Pure rotational Raman spectra	1	3[10]	Lec	Ess	1
3.4	Raman activity of vibrations	1	3[5]	Lec	Ess	1
3.5	Mutual exclusion principle	0.5	3[10]	OO	SA	1
3.6	Overtones and combination vibrations	0.5	3[5]	Lec	SA	1
3.7	Vibrational Raman spectra	1	3[10]	Lec	SA	1
3.8	Rotational fine structure	1	3[5]	Lec	Ess	1
3.9	Polarization of light and the Raman effect	1	3[10]	Lec	SA	1
3.10	Structure determination from Raman and IR spectroscopy	1	3[10]	Lec	Ess	1
3.11	Techniques and instrumentation	1	3[10]	PT	Ess	1
3.12	Near Infra-Red FT-Raman Spectroscopy	1	3[10]	OO	SA	1
3.13	Fermi Resonance	1	3[5]	Lec	Ess	1
IV	**NMR AND ESR SPECTROSCOPY**					

4.1	Introduction to NMR	0.5	4[10]	GD	MCQ	2
4.2	Resonance Condition	0.5	4[10]	Lec	SA	2
4.3	Width of absorption lines in NMR	1	4[10]	Lec	SA	2
4.4	Chemical Shift	1	4[10]	Lec	SA	2
4.5	Factors Influencing Chemical Shift	1	4[10]	PT	Ess	2
4.6	Coupling Constants	0.5	4[10]	Lec	SA	2
4.7	NMR Instrumentation	1	4[10]	Lec	SA	2
4.8	Limitations of NMR	0.5	4[10]	Lec	Ess	2
4.9	Theory of ESR	1	4[10]	GD	SA	2
4.10	ESR Instrumentation	1	4[10]	PT	Ess	2
4.11	Hyperfine splitting of ESR	1	4[10]	Lec	Ess	2
4.12	Determination of g-value	1	4[10]	GD	SA	2
4.13	General applications	1	4[10]	Lec	SA	2
4.14	NMR Imaging	1	4[10]	Lec	SA	2
V	**SURFACE ANALYTICAL TOOLS**					
5.1	Atomic Absorption spectroscopy – principles and Grotrian diagram	1	5[10]	GD	Ess	2
5.2	Advantages and disadvantages of AAS	1	5[5]	Lec	Sem	2
5.3	Applications of AAS	1	5[5]	Lec	Sem	2
5.4	Singlet and Triplet states and exited state process in fluorimetry	1	5[5]	Lec	Ess	2
5.5	Applications of Photoluminescnce	1	5[5]	PT	Sem	2
5.6	Photo electron Spectroscopy (PES)	1	5[10]	GD	Ess	2
5.8	Scanning Electron Microscope (SEM)	1	5[10]	PT	Sem	1
5.9	Reflection – Absorption IR Spectroscopy (RAIRS)	1	5[10]	GD	Ess	1
5.10	Surface enhanced Raman scattering (SERS)	1	5[10]	PT	Ess	1

5.11	Auger electron spectroscopy (AES)	1	5[10]	Lec	SA	1
5.12	X-ray Fluorescence spectroscopy (XRF)	1	5[10]	GD	SA	1
5.13	Transmission Electron Microscope (TEM)	1	5[10]	Lec	SA	

BOOKS FOR REFERENCE:

1. Colin N. Banwell and Elaine M. McCash, Fundamentals of Molecular Spectroscopy IV Ed., Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2016.
2. G. Aruldhas, Molecular Structure and Spectroscopy 2nd Ed., PHI Learning (P) Ltd., New Delhi, 2008.
3. Robert M. Silverstein, Francis X. Webster, Spectrometric Identification of Organic Compounds VI Ed., John Wiley & Sons, Inc., New York, 2003.
4. A.K. Chandra, Introductory Quantum Chemistry, Tata McGraw Hill, New Delhi, 2006.
5. Ferraro, J. R., Nakamoto, K. & Brown, C. W., (2005). Introduction to Raman Spectroscopy, (2nd ed.), New Delhi: Elsevier India Pvt Ltd. Print.
6. N.B. Clothup; L.H. Daly; S.E. Wiberley, Introduction to Infrared and Raman Spectroscopy, Academic Press, 1990, third edition.
7. Y.R. Sharma, "Elementary Organic Spectroscopy", S. Chand Company & Ltd., New Delhi (2009).
8. Antonin Blazek, "Thermal Analysis", Van Nostrand Reinhold Company Ltd., Bucingham Gate, London, (1972).

Course Title: **ARDUINO HARDWARE & PROGRAMMING**		Course Type: **Practical III**
		Course Code: **23PPP3**
Total Hours: **90**	Hours/Week: **6**	Credits: **4**
Pass-Out Policy : Minimum Contact Hours: 54 Total Score %: **100** Internal: **40** External: **60** Minimum Pass %: **50** [No Minimum for Internal]		
Course Creator:	**Expert 1:**	**Expert 2:**
Prof. A. Charles Hepzy Roy	**Dr. C. James**	**Dr. S. Sharmila Juliet**
Asso. Prof., Faculty Head	Asso. Prof. of Physics	Assi. Prof. of Physics
+919944261881	**+919489500237**	**+919487094860**
achroy66@gmail.com	**james@scottchristian.org**	**sharmilabennet@gmail.com**

CLO-No.	**Course Learning Outcome** ***Upon completion of this course, students will be able to:***	PLO % MAPPED WITH CLO	LO & PLO MAPPED WITH GA	Cognitive Level CL	Knowledge Catogory KC

CLO-1	Learn the Arduino platform and programming language to create robots, interactive art displays, electronic toys, home automation tools, and much more. This course was created in collaboration with Hackster.	**6[10] 10[10]**	**2,5,10**	**R, U**	**P**
CLO-2	Learn to program in Arduino (C/C++) and build electronics that sense and react to the environment	**6[10] 10[10]**	**2,5,10**	**U, Ap**	**P**
CLO-3	Remotely log data to an Internet of Things (IoT) platform	**6[10] 10[10]**	**2,5,10**	**An**	**P**
CLO-4	Use the Internet to control your Arduino from anywhere in the world	**6[10] 10[10]**	**2,5,10**	**An, E**	**P**
CLO-5	Master the skills needed to bring your projects to life through electronics.	**6[10] 10[10]**	**2,5,10**	**E, C**	**P, M**

Any six from the following list of experiments with at least one from each group

Group	Experiments
1	**Measurements:** 1. Monitor and display analog voltage from devices such as potentiometer or sensors. 2. Flash an LED to indicate a low voltage level (falls below a threshold). 3. Measure capacitance of a capacitor and display the result in a serial monitor through serial port. 4. Using an ultrasonic distance sensor (HC-SR04), measure the distance of an object and also display the distance on the Serial Monitor and flash an LED faster as objects get closer. 5. Display the temperature or switch on an LED when the temperature reaches a threshold. 6. Develop a Lux meter to measure the brightness of the light falling on the sensor. 7. Forecast the weather by measuring both atmospheric pressure and temperature.
2	**Sensors:** 8. Detect if an object is moved, tilted, or shaken: Switch on one LED when the tilt sensor is tilted one way, and other LED when it is tilted the other way. 9. Detect a change when something passes in front of a light detector or measure the light level. 10. Using a motion sensor such as a Passive Infrared (PIR) sensor, detect the change values on a digital pin or switch on an LED when

	someone moves nearby. 11. Using Piezo sensor (knock sensor), switch on an LED when there is a vibration or someone knocks a door or an object. 12. Forecast weather by Temperature and Humidity Measurement using DHT11 Sensor.
3	**Actuators:** 13. Turn the brushed motor on and off and controls its speed by commands passed on the serial port. 14. Control the direction of a brushed motor with an H-Bridge to rotate in one direction or the other from serial port commands. 15. Control the direction and speed of brushed motors with feedback from photo sensors. 16. Rotate bipolar (four-wire) stepper motor under program control using an H-Bridge. A numeric value followed by a + steps in one direction; a - steps in the other. 17. Play audio tones through a speaker or other audio transducer with the frequency set by a variable resistor (or other sensor) connected to analog input. 18. Using tone function play a string of sounds corresponding to notes on a musical instrument.
4	**Prototypes:** 19. Display your name and register number in a LCD based on the industry- standard HD44780 or similar one. 20. Determine the duration of a pulse with microsecond accuracy; OR measure the exact time between two button presses. 21. Display heart beating (small and large) in an 8×8 dot matrix with MAX7219. 22. Build a traffic lights system for a junction. Use LEDs of colours Green, Red and Yellow and blink before changing. 23. Control an LED brightness using a potentiometer and display the LED brightness on the LCD screen using a progress bar. 24. Parking sensor: Measure the distance and an LED bar graph that lights up accordingly to the distance from the sensor. Getting closer to the sensor must be alerted with a buzzer beeps in a different way. 25. Build a MQ-2 Gas/Smoke detector that beeps when it detects flammable gas or smoke. 26. Night security light with a relay module, a photo-resistor, which turns on when it is dark and when movement is detected.

Course Title:	**ELECTRONIC DEVICES & CIRCUITS**	Course Type: **Theory** Course Code: 23PPED

Total Hours: **75**	Hours/Week: **5**	Credits: **4**
Pass-Out Policy : Minimum Contact Hours: 45 Total Score %: **100** Internal: **40** External: **60** Minimum Pass %: **50** [No Minimum for Internal]		
Course Creator:	**Expert 1:**	**Expert 2:**
Prof. A. Charles Hepzy Roy	**Dr. D. Hudson Oliver**	**Dr. S. Sharmila Juliet**
Asso. Prof., Faculty Head	Assi. Prof. of Physics	Assi. Prof. of Physics
+919944261881	+919952654515	**+919487094860**
achroy66@gmail.com	hudson2612@gmail.com	**sharmilabennet@gmail.com**

CLO No.	**Expected Course Learning Outcome** *Upon completion of this course, the students will be able to:*	PLO % MAPPED WITH CLO	CLO & PLO MAPPED WITH GA	Cognitive Level CL	Knowledge Catogory KC
CLO-1	Comprehend the operational principles of semiconductor devices.	**5[10] 6[10]**	**1,2,5, 6,10**	**U, Ap**	**C, F**
CLO-2	Examine the functionality of optoelectronic devices and their underlying mechanisms.	**5[10] 6[10]**	**1,2,5, 6,10**	**R, E**	**F, P**
CLO-3	Utilize fundamental principles to investigate the operation of photodetectors.	**5[10] 6[10]**	**1,2,5, 6,10**	**Ap, C**	**P**
CLO-4	Employ operational amplifiers for diverse applications and functionalities.	**5[10] 6[10]**	**1,2,5, 6,10**	**U, Ap, C**	**P, M**
CLO-5	Perform experiments involving transducers, and proficiently manage the Asso.d signals.	**5[10] 6[10]**	**1,2,5, 6,10**	**U Ap, An**	**M**

Module	**Course Description**	**Hours**	**% CLO Mapping with Module**	**Learning Activitie**	**Assessment Tasks**	**Reference**
I	**ABSTRACT GROUP THEORY**					
1.1	Diodes – Modes of operation	1	1[10]	Lec	SA	1
1.2	DC analysis – AC small signal analysis	2	1[8]	Lec	Ess	1
1.3	Reverse breakdown model	1	1[8]	PT	SA	1
1.4	Transistors – Transistor characteristics	1	1[8]	Lec	SA, MC Q	1
1.5	DC biasing – modes of operation	1	1[8]	PT	SA	1
1.6	DC analysis	1	1[10]	EL	SA	1
1.7	AC analysis	1	1[8]	EL	Ess	1
1.8	Field effect transistors	1	1[8]	Lec	SA,	1
1.9	DC analysis	1	1[7]	Lec	SA	1
1.10	AC analysis	1	1[9]	Lec	Ess	1

1.11	Silicon controlled rectifiers	1	1[8]	EL	Mpr o	1
1.12	DIAC-Characteristics	1	1[8]	EL	Ess	1
1.13	TRIAC – Characteristics	1	1[10]	EL	Ess	1
II	**OPTOELECTRONIC DEVICES**					
2.1	Light emitting diodes	1	2[7]	GD	SA	2,3
2.2	Device configuration and efficiency	2	2[8]	Lec	Ess	2,3
2.3	Extraction efficiency and external conversion efficiency	1	2[8]	GD	Ess	2,3
2.4	Hetero junction LED	0. 5	2[8]	Lec	Ess	2,3
2.5	Spectral response – LEDs for display applications	1	2[7]	BS	SA. MC Q	2,3
2.6	Lasers: Einstein relation for population inversion	1	2[8]	Lec	Ess	2,3
2.7	Threshold condition for lasing	1	2[7]	Lec	SA	2,3
2.8	Applications of semiconductor lasers	1	2[8]	GD	MC Q	2,3
2.9	Hetero junction lasers	0. 5	2[8]	Lec	Ess	2,3
2.10	Quantum well lasers-Device fabrication	1	2[8]	Lec	SA	2,3
2.11	Measurement of Laser characteristics	1	2[8]	EL	SA	2,3
2.12	Solar cells – spectral response	0. 5	2[7]	Lec	Ess	2,3
2.13	solar cell design	0. 5	2[8]	Lec	SA	2,3
III	**PHOTO DETECTORS**					
3.1	AC and DC photoconductors	1	3[9]	Lec	MC Q	2,3
3.2	Gain and bandwidth	1	3[9]	GD	SA	2,3
3.3	Measurement of multiplication factor	1	3[9]	Lec	Ess	2,3
3.4	Noise performance	1	3[9]	GT	SA	2,3
3.5	Avalanche photodiode	1	3[10]	Lec	Ess	2,3
3.6	Impulse response measurement	1	3[9]	Lec	SA	2,3
3.7	Photo transistors	1	3[9]	GD	Ess	2,3
3.8	Metal semiconductor photodiodes	1	3[9]	Lec	Ess	2,3
3.9	Metal semiconductor metal photo diode	1	3[9]	Lec	Ess	2,3
3.10	Wavelength selection	2	3[9]	GD	SA	2,3
3.11	Coherent detection	1	3[9]	Lec	Ass	2,3
IV	**OPERATIONAL AMPLIFIERS**					
4.1	Op-amp characteristics, equivalent circuit	1	4[7]	GD	SA	4
4.2	Open loop configuration – inverting, Non-inverting	1	4[8]	PT	SA	4
4.3	Practical op-amp input offset voltage, CMRR	1	4[8]	PT	SA	4
4.4	total output offset voltage	1	4[8]	EL	Ess	4
4.5	Input bias current, input offset current	1	4[7]	EL	Ess	4

4.6	Op-amp with negative feed back	1	4[8]	EL	Ess	4
4.7	Adder, subtractor, multiplier	1	4[7]	Lec	Ess	4
4.8	Integrator, Differentiator	1	4[8]	Lec	Ess	4
4.9	Analog computation	1	4[8]	EL	Ess	4
4.10	Oscillator – principle – types phase shift	1	4[8]	GD	SA,Ess	4
4.11	LC tunable oscillator	1	4[8]	EL	Ess	4
4.12	Nonlinear Oscillator Square, Triangular	1	4[7]	EL	Ess	4
V	**EXPERIMENTAL TECHNIQUES**					
5.1	Transducers – characteristics	1	5[11]	Lec	SA,	5
5.2	Temperature, pressure, piezoelectric	2	5[11]	GD	Ess	5
5.3	Capacitance	1	5[11]	Lec	SA	5
5.4	Low temperature – thermometry	1	5[9]	Lec	Ess	5
5.5	Thermal detectors – photoconductive	2	5[9]	PT	SA,Ess	5
5.6	Signal to noise	1	5[9]	PT	SA	5
5.7	Fourier analysis	1	5[15]	Lec	Ess	5
5.8	Sources of noise	1	5[15]	GD	SA,	5
5.9	Signal to noise and experimental design	2	5[10]	Lec	Ess	5

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1. Mathew M. Radmanesh, Radiofrequency and Microwave Electronics Illustrated, Addison-Wesley Longman Pvt., Ltd, Singapore, 2001.
2. S.M. Sze, Physics of Semiconductor Devices, Second Edition, John Wiley & Sons, New York, 2004.
3. Pallab Bhattacharya, Semiconductor Optoelectronic Devices, Eastern Economic Edition, Second Edition, Prentice-Hall of India Pvt., Ltd, New Delhi, 2002.
4. Tobey-Graeme-Huelsman, Operational Amplifiers Design and Application, McGraw-Hill Book Company, New Delhi, 1981.
5. Ian Sinclair, Sensors and Transducers, Elsevier, Amsterdam, 2000
6. John D, Ryder, Electronic Fundamentals and Applications, Fifth Edition, Eastern Economy Edition, Prentice-Hall of India Pvt., Ltd, New Delhi, 2003.
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8. M.S. Tyagi, Introduction to Semiconductor Materials and Devices, John Wiley & Sons, New York, 1991.

SEMESTER IV

Course Title: **SOLID STATE PHYSICS – II**		Course Type: **Theory**
		Course Code: **23PP41**
Total Hours: **90**	Hours/Week: **6**	Credits: **4**
Pass-Out Policy : Minimum Contact Hours: 54 Total Score %: Internal: **40** External: **60** Minimum Pass %: **50** [No Minimum for Internal]		
Course Creator:	**Expert 1:**	**Expert 2:**
Prof. A. Charles Hepzy Roy	**Dr. C. Besky Job**	**Dr. Y. Sheeba Sherlin**
Asso. Prof., Faculty Head	Asso. Prof. of Physics	Asso. Prof.of Physics
+919944261881	+919487026024	**+919442304397**

achroy66@gmail.com	cbjob1969@gmail.com	ysheebamohan@gmail.com

CLO No.	Expected Course Learning Outcome *Upon completion of this course, students will be able to:*	PLO % MAPPED WITH CLO	CLO & PLO MAPPED WITH GA	Cognitive Level CL	Knowledge Catogory KC
CLO- 1	Recognize material properties of matter with necessary theory and Understand the theory of free electron Fermi gas and the Asso.d heat capacity, thermal and electrical conductivity	2[10] 7[10]	1,2,3	R, U	C
CLO- 2	Explain the energy bands and gaps with theoretical background	2[10] 7[10]	1,2,3	U, Ap	F
CLO- 3	Elucidate the conduction phenomena in crystals and their career concentration	2[10] 7[10]	1,2,3	An	F, P
CLO- 4	Explain the concept behind semiconducting materials	2[10] 7[10]	1,2,3	An, E	M
CLO-5	Explain the concept behind superconducting materials	2[10] 7[10]	1,2,3	E, C	P, M

Module	Course Description	Hours	% CLO Mapping with Module	Learning Activitie	Assessment Tasks	Reference
I	**FREE ELECTRON FERMI GAS**					
1.1	Energy levels in one dimension	1	1[5]	Lec	Ess	1
1.2	Free electron gas in 3D	1	1[10]	Lec	Ess	1
1.3	Heat capacity in 3D	1	1[10]	Lec	SA	1
1.4	Heat capacity of the electron gas	1	1[5]	Lec	SA	1
1.5	Experimental heat capacity of metals	1	1[10]	Lec	Ess	1
1.6	Electrical conductivity and ohms law	1	1[5]	Lec	MCQ	1
1.7	Experimental electrical resistivity of metals	1	1[10]	Lec	SA	1
1.8	Umklapp scattering	1	1[5]	TPS	SA	1
1.9	Motion in magnetic fields	1	1[10]	Lec	Ess	1
1.10	Thermal conductivity of metals	1	1[10]	GD	SA	1

1.11	Ratio of thermal to electrical conductivity	1	1[10]	CL	SA	1
1.12	Nanostructures	1	1[10]	CL	Ass	1
II	**ENERGY BANDS**					
2.1	Nearly free electron model	0.5	2[10]	Lec	SA	1
2.2	Origin of energy gap	0.5	2[5]	Lec	SA	1
2.3	Magnitude of the energy gap	1	2[5]	Lec	Ess	1
2.4	Bloch function `	0.5	2[5]	Lec	SA	1
2.5	Kronig Penney model	0.5	210]	BS	Ess	1
2.6	Wave equation in a periodic potential	1	2[5]	Lec	Ess	1
2.7	Crystal momentum of an electron	1	2[5]	Lec	SA	1
2.8	Solution of the central equation	1	2[5]	Lec	Ess	1
2.9	Number of orbitals in a band	1	2[10]	Lec	Ess	1
2.10	Metals and insulators	0.5	2[10]	Lec	SA	1
2.11	Fermi surface construction	0.5	2[5]	Lec	Ess	1
2.12	Electrons orbits, hole orbits and open orbits	1	2[10]	BS	Ess	1
2.13	Calculation of energy bands	1	2[5]	BS	Ess	1
2.14	Wigner-Seitz method	1	2[5]	BS	Ess	1
2.15	DeHass- van alpha effects	1	2[5]	BS	Ess	1
III	**SEMICONDUCTOR CRYSTALS**					
3.1	Properties and application of semiconductors	1	3[10]	Lec	SA	3
3.2	Effective mass	1	3[5]	Lec	SA	1
3.3	Physical interpretation of the effective mass of an electron	1	3[10]	Lec	Ess	1
3.4	Effective mass in semiconductor	1	3[10]	Lec	SA	1
3.5	Intrinsic carrier concentration	1	3[10]	Lec	Ess	1
3.6	Carrier concentration in n-type semiconductors	1	3[10]	Lec	SA	3
3.7	Carrier concentration in p-type semiconductors	1	3[10]	Lec	MCQ	3
3.8	Hall effect – determination of Hall co-efficient	1	3[10]	TPS	Ess	3
3.9	P-N Junction	1	3[5]	TPS	SA	1
3.10	Rectification	1	3[5]	Lec	SA	1
3.11	Energy in Si and Ge	1	3[5]	Lec	Ess	1

3.12	Electron-phonon interaction: polarons	1	3[10]	BS	Ess	1
IV	**SUPERCONDUCTIVITY**					
4.1	Experimental survey, Occurrence of superconductivity	1	4[5]	GD	MCQ	2
4.2	Meissner effect, heat capacity, energy gap	1	4[10]	Lec	SA	2
4.3	Microwave and infrared property, isotope effect	1	4[10]	Lec	SA	2
4.4	London equations	1	4[10]	Lec	Ess	2
4.5	BCS theory of super conductor	1	4[10]	Lec	Ess	2
4.6	Type I superconductor	1.5	4[10]	Lec	Ess	2
4.7	Type II superconductor	1.5	4[10]	Lec	SA	2
4.8	Applications of Super Conductors	1	4[5]	Lec	SA	2
4.9	High Tc Super Conductors	1	4[10]	Lec, GD	Ess, MCQ	2
4.10	AC Josephson effect	1	4[10]	Lec	Ess	2
4.11	DC Josephson effect	1	4[10]	Lec	Ess	2
V	**DIA, PARA AND FERROMAGNETISM**					
5.1	Susceptibility, diamagnetism	1	5[10]	Lec	MCQ	2
5.2	Langevin diamagnetic equation	1	5[5]	Lec	Ess	2
5.3	Langevin Paramagnetic equation	1	5[5]	Lec	Ess	2
5.4	Quantum theory of paramagnetism	1	5[10]	Lec	Ess	2
5.5	Paramagnetic susceptibility of conduction electrons	2	5[10]	Lec	Ess	2
5.6	Ferromagnetic order, curie point and exchange integral	1	5[10]	Lec	SA	2
5.7	Properties and applications of Hard magnetic Materials	1	5[10]	Lec	Ess	3
5.8	Alnico alloys, NdFeB magnets, SMCo magnets and hard ferrites	1	5[10]	Lec, GD	Ess, SA	3
5.9	Properties and applications of soft magnetic materials	1	5[10]	Lec	SA	3
5.10	Iron silicon alloys, permalloy	1	5[10]	Lec, FW	Ess, MCQ	3
5.11	Ferrites, Garnets, Amorphous magnets.	1	5[10]	Lec, FW	Ess, MCQ	3

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1. Charles Kittel, Introduction to Solid State Physics, Wiley Eastern P. Ltd, Seventh Edition, 2000
2. Solid State Physics, Bhima Shankaran, BS Publications, Hyderabad, 2002.
3. Solid State Physics, Dr. K.Ilangovan, MJP Publishers, Chennai, 2013.
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5. M. Arumugam, Solid State Physics, Anuradha Agencies, 2004
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Course Title:	**THERMODYNAMICS & STATISTICAL PHYSICS**	Course Type: **Theory**
		Course Code: **23PP42**
Total Hours: **90**	Hours/Week: **6**	Credits: **4**
Pass-Out Policy : Minimum Contact Hours: 54 Total Score %: **100** Internal: **40** External: **60** Minimum Pass %: **50** [No Minimum for Internal]		
Course Creator:	**Expert 1:**	**Expert 2:**
Prof. A. Charles Hepzy Roy	**Dr. Y. Premila Rachelin**	**Dr. V. Anslin Ferby**
Asso. Prof., Faculty Head	Asso. Prof. of Physics	Prof. of Physics
+919944261881	**+919489620591**	**+919443595694**
achroy66@gmail.com	**premilarachelin@gmail.com**	**anslinv@gmail.com**

CLO No.	**Expected Course Learning Outcome** ***Upon completion of this course, students will be able to:***	**PLO % MAPPED WITH CLO**	**CLO & PLO MAPPED WITH GA**	**Cognitive Level CL**	**Knowledge Catogory KC**
CLO- 1	Explain the phenomenological introduction to thermodynamics through thermodynamics postulates, quantities and relations	**8[20]**	**1,3,5, 7,8,9**	**R, U**	**C**
CLO- 2	Assess the behaviour of ideal gas, black body, specific heat of solids and to deduce Bose Einstein statistical distribution functions.	**8[20]**	**1,3,5, 7,8,9**	**U, Ap**	**C, F**
CLO- 3	Analyse the phenomena of specific heat of gases and deduce and Fermi Dirac distribution law.	**8[20]**	**1,3,5, 7,8,9**	**An**	**F, P**
CLO- 4	Interpret the idea on postulates of statistical mechanics, statistical interpretation of thermodynamics	**8[20]**	**1,3,5, 7,8,9**	**An, E**	**P**

	and understand thermodynamical quantities in terms of partition function				
CLO-5	Categorize the phase transitions and understand the statistical equilibrium in semiconductors	**8[20]**	**1,3,5, 7,8,9**	**E, C**	**M**

Module	**Course Description**	**Hours**	**% CLO Mapping with Module**	**Learning Activitie**	**Assessment Tasks**	**Reference**
I	**THERMODYNAMICS**					
1.1	Review of thermodynamics - Definition of terms	1	1[10]	Lec	CA	1
1.2	First law, second law and third law	1	1[10]	Lec	CT	1
1.3	Gibb's free energy and Helmholtz' free energy	1	1[10]	Lec	HoA	1
1.4	Thermodynamical potential	1	1[5]	GD	SA	1
1.5	Phase-space, Ensembles	1	1[5]	Sem	Quiz	1
1.6	Micro canonical, canonical and grand canonical ensembles	1	1[5]	TPS	HrA	2
1.7	Chemical potential – Density of states – Liouville's theorem	1	1[10]	PT	Ess	2
1.8	Probability consideration of tossing of distinguishable and indistinguishable coins	1	1[10]	Sem	CA	2
1.9	General expression for probability of distribution – Stirling's formula	1	1[10]	Lec	HoA	3
1.10	Most probable distribution	1	1[5]	GD	Quiz	3
1.11	Maxwell-Boltzmann's distribution law	1	1[10]	Lec	Ess	3
1.12	Law of equipartition of energy	1	1[10]	Lec	SA	3
II	**QUANTUM STATISTICS**					
2.1	Quantum statistics of identical particles	1	2[5]	GD	HoA	4
2.2	Density matrix and limitations	1	2[5]	TPS	CA	4
2.3	Bose-Einstein distribution law	1	2[20]	Lec	Ess	4
2.4	Black body radiation – Planck's radiation law	1	2 [20]	Lec	Ess	4
2.5	Specific heat of solids	1	2[5]	PT	Quiz	4
2.6	Einstein theory	2	2[10]	Sem	Ess	5
2.7	Debye's theory	2	2[10]	Lec	CA	5
2.8	Ideal Bose-Einstein gas	1	2[5]	Lec	Ess	5
2.9	Degeneracy of Bose- Einstein gas	1	2[15]	Lec	CA	5
2.10	Bose-Einstein Condensation	1	2[5]	Lec	SA	5
III	**SPECIFIC HEAT OF GASES**					
3.1	Fermi-Dirac distribution law	1	3[10]	Lec	Ess	4
3.2	Ideal Fermi-Dirac gas	1	3[5]	GD	Quiz	4
3.3	Fermi energy	1	3[5]	TPS	Ess	4
3.4	Degeneracy	1	3[5]	Sem	CA	5

3.5	Weak degeneracy, strong degeneracy	1	3[10]	Sem	Ess	5
3.6	Electron gas in metals	1	3[15]	Lec	Ess	6
3.7	Thermionic emission of electrons	2	3[15]	Lec	Ess	6
3.8	Specific heat of gases	1	3[5]	PT	SA	6
3.9	Monoatomic, diatomic and polyatomic gases	2	3[15]	GD	CA	6
3.10	Variation of atomicity with temperature	1	3[15]	GD	HoA	6
IV	**PARTITION FUNCTION**					
4.1	Relation between statistical and thermodynamical quantities	1	4[5]	GD	Quiz	7
4.2	Partition function	1	4[5]	Sem	SA	7
4.3	Partition function and thermodynamical quantities	2	4[20]	Lec	Ess	7
4.4	Entropy mixing and Gibbs' paradox	1	4[20]	Lec	Ess	7
4.5	Saucker-tetrode equation for entropy	1	4[10]	Lec	CA	7
4.6	Molecular partition function	1	4[5]	Sem	SA	8
4.7	Translational partition function	1	4[5]	Lec	Ess	8
4.8	Rotational partition function	1	4[5]	Lec	Ess	8
4.9	Vibrational partition function	1	4[5]	Lec	Ess	8
4.10	Application of rotational partition function	1	4[10]	Sem	Ess	8
4.11	Application of vibrational partition function	1	4[10]	Sem	Ess	8
V	**SEMICONDUCTOR STATISTICS**					
5.1	Statistical equilibrium of free electrons in semiconductors	1	5[10]	GD	SA	1
5.2	Non-degenerate semiconductors	1	5[15]	Lec	Ess	1
5.3	Degenerate semiconductors	1	5[15]	Lec	SA	1
5.4	Impurity semiconductors	1	5[10]	Lec	CA	1
5.5	Non equilibrium semiconductors	1	5{10]	Sem	Ess	1
5.6	Fluctuation in energy	1	5[10]	Lec	SA	1
5.7	Fluctuations in concentration	2	5[15]	Lec	Ess	1
5.8	First order Phase transitions	1	5[15]	Sem	Ess	5
5.9	Second order Phase transitions	1	5[15]	Sem	Ess	5

BOOKS FOR REFERENCE:

1. Sears and Salinger, Thermodynamics, Addison-Wesley Publishing Co., 1975.
2. Kerson and K. Huang, Statistical Mechanics, John Wiley & Sons, Inc., New York, 1963.
3. A.K. Dasgupta, Fundamentals of Statistical Mechanics, New Central Book Agency (P) Ltd., Calcutta, 2000.
4. Sears and Zymanski, Statistical Mechanics, McGraw Hill Book Company, New York, 1961.
5. A.K. Agarwal and Melvin Eisner, Statistical Mechanics, New Age International (P) Limited, New Delhi, 1998.
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11. R.K. Srivastava, Statistical Mechanics, PHI, 2005.

Course Title:	**NUCLEAR AND PARTICLE PHYSICS**	Course Type: **Theory**
		Course Code: **23PP43**
Total Hours: **90**	Hours/Week: **6**	Credits: **4**
Pass-Out Policy : Minimum Contact Hours: 54 Total Score %: **100** Minimum Pass %: **50** [No Minimum for Internal]	Internal: **40**	External: **60**
Course Creator:	**Expert 1:**	**Expert 2:**
Prof. A. Charles Hepzy Roy	**Dr.T.R. Beena**	**Dr. D.J. Jeejamol**
Asso. Prof., Faculty Head	Assi. Prof. of Physics	Assi. Prof. of Physics
+919944261881	**9487386199**	**+917598629087**
achroy66@gmail.com	**trbeena@gmail.com**	**lomajeej@gmail.com**

CLO-No.	**Course Learning Outcome** ***Upon completion of this course, students will be able to:***	**PLO % MAPPED WITH CLO**	**CLO & PLO MAPPED WITH GA**	**ognitive Level CL**	**Knowledge Catogory KC**
CLO-1	Get a thorough knowledge on constituents of nucleus with a good idea in nuclear properties and nuclear forces. Analyze scattering problems so as to understand nucleon-nucleon interaction.	**4[10] 8[10]**	**1,2,6, 7,9**	**An**	**C**
CLO-2	List out and describe various kinds of nuclear reactions. Explain, classify and compare different nuclear models.	**4[10] 8[10]**	**1,2,6, 7,9**	**An**	**F**
CLO-3	Distinguish and examine theories of different radioactive decay processes.	**4[10] 8[10]**	**1,2,6, 7,9**	**U**	**P**
CLO-4	Make use of nuclear fission and fusion concepts in nuclear reactors as well as acquire knowledge in designing the reactors.	**4[10] 8[10]**	**1,2,6, 7,9**	**R, C**	**C, P**
CLO-5	Understand interaction between the elementary particles discovered so far. Classify elementary particles and elaborate their knowledgeon quarks.	**4[10] 8[10]**	**1,2,6, 7,9**	**E**	**M**

Module	Course Description	Hours	% CLO Mapping with Module	Learning Activitie	Assessment Tasks	Reference
I	**NUCLEAR FORCES AND DEUTERON PROBLEMS**					
1.1	Nuclear forces	1	1[5]	Lec	SA	1
1.2	Binding energy	1	1[10]	Lec	Qui	1
1.3	Weizsacker semi empirical mass formula	1	1[15]	GD	Ess	1
1.4	Ground and excited state of deuteron	2	1[10]	BS	Sem	1
1.5	Meson theory of nuclear forces	1	1[10]	Lec	Ess	1
1.6	Neutron – proton scattering of low energies	1	1[15]	GD	Ess	1
1.7	Phase shift analysis scattering length	2	1[15]	GD	SA	1
1.8	Effective range theory in n-p scattering	1	1[10]	BS	Sem	1
1.9	Spin dependence of nuclear forces and charge independence of nuclear forces.	2	1[10]	TPS	Ass	1
II	**NUCLEAR REACTIONS AND MODELS**					
2.1	Kinds of nuclear reactions	1	2[10]	Lec	SA	1
2.2	Nuclear cross-section	1	2[5]	TPS	SA	1
2.3	Partial wave analysis of reaction crosssection	1	2[10]	Lec	Ess	1
2.4	Compound nucleus	1	2[10]	GD	Sem	1
2.5	Inverse process (Reciprocity theorem)	1	2[10]	BS	Ass	1
2.6	Cross section of nuclear reaction	1	2[10]	TPS	Ass	1
2.7	Resonance	1	2[5]	Lec	SA	1
2.8	Briet Wigner one level formula	2	2[10]	OO	Ess	1
2.9	Liquid drop model	1	2[5]	GD	Ess	1
2.10	Shell model	2	2[10]	GD	Sem	1
2.11	Extreme single particle model	2	2[10]	GD	Ass	1
2.12	Predictions of shell model	1	2[5]	BS	MCQ	1
III	**RADIOACTIVE DECAY**					
3.1	α-decay - Gamow‟s theory	2	3[10]	Lec	Es	1

					s	
3.2	β-decay – Fermi‟s theory	2	3[10]	Lec	Es s	1
3.3	Pauli‟s neutrino hypothesis	1	3[10]	GD	SA	1
3.4	Angular momentum and parity selection rules	1	3[10]	BS	Se m	1
3.5	Violation of parity conservation in β decay	1	3[10]	BS	As s	1
3.6	Gamma decay	1	3[10]	Lec	Es s	1
3.7	Electric and magnetic multipole radiation	1	3[10]	GD	Es s	1
3.8	Selection rules	1	3[10]	TPS	As s	1
3.9	Internal conversion	1	3[10]	Lec	SA	1
3.10	Nuclear isomers	1	3[10]	Lec	Qu i	1
IV	**NUCLEAR FISSION, FUSION AND REACTORS**					
4.1	Types of fission	1	4[6]	Lec	Es s	1
4.2	Distribution of fission products	1	4[6]	Lec	Es s	1
4.3	Mass and energy	0. 5	4[7]	GD	SA	1
4.4	Bohr Wheeler theory	1	4[7]	Lec	Se m	1
4.5	Barrier penetration	0. 5	4[7]	BS	As s	1
4.6	Theory of spontaneous fission	1	4[7]	TPS	Es s	1
4.7	Nuclear chain reaction four factor formula	1	4[8]	GD	As s	1
4.8	Critical size	0. 5	4[8]	BS	Se m	1
4.9	Neutron emission	1	4[7]	Lec	SA	1
4.10	Diffusion equation	1	4[7]	GD	Es s	1
4.11	Reactor design	2	4[8]	BS	Qu i	1
4.12	Classification of reactors - Nuclear fusion	1	4[7]	Lec	Es s	1
4.13	Thermo nuclear energy	0. 5	4[7]	Lec	As s	1
4.14	Controlled thermo nuclear reactions.	1	4[8]	GD	Se m	1
V	**ELEMENTARY PARTICLES**					
5.1	Types of interaction	0.	7[15]	Lec	SA	1

		5				
5.2	Classification of elementary particles	1	8[17]	Lec	Qu i	1
5.3	Conservation laws	0. 5	7[15]	GD	Es s	1
5.4	Elementary ideas CP and CPT invariance	1	7[15]	BS	Es s	1
5.5	Classification of hadrons	1	8[17]	Lec	SA	1
5.6	SU(2) and SU(3) symmetries	2	7[15]	GD	Es s	1
5.7	Baryon octet – Meson octet	1	7[14]	OO	As s	1
5.8	Baryon decuplet	1	7[14]	OO	As s	1
5.9	Gellmann Okubo mass formula	2	7[12]	GD	Es s	1
5.10	Quarks – Flavours and colors	1	8[17]	Lec	Es s	1
5.11	Quark model of the nuclei	1	8[17]	BS	Se m	1
5.12	The Standard model.	1	8[16]	Lec	As s	1
5.13	Higgs Bosons	1	8[16]	GD	Se m	1

BOOKS FOR REFERENCE:

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2. V. Devanathan, Nuclear Physics, Narosa Publication, New Delhi, 2006.
3. Roy and Nigam, Nuclear Physics, Wiley Eastern Ltd., New Delhi, 1980.
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11. Herald A. Enge, Introduction to Nuclear Physics, I Edi. Addition Wesly, 1966.
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Holland Publishing Co.,Amsterdam, 1972.

Course Title:	**NUMERICAL METHODS & MATLAB**	Course Type: **Theory**
		Course Code: **23PPEE**
Total Hours: **90**	Hours/Week: **6**	Credits: **4**
Pass-Out Policy : Minimum Contact Hours: 54 Total Score %:**100** Internal: **40** External: **60** Minimum Pass %: **50** [No Minimum for Internal]		
Course Creator:	**Expert 1:**	**Expert 2:**
Prof. A. Charles Hepzy Roy	**Dr. C. James**	**Dr. V. Anslin Ferby**
Asso. Prof., Faculty Head	Asso. Prof. of Physics	Asso. Prof. of Physics
+919944261881	**+919489500237**	**+919443595694**
achroy66@gmail.com	**james@scottchristian.org**	**anslinv@gmail.com**

CLO No.	**Expected Course Learning Outcome** ***Upon completion of this course, the students will be able to ….***	**PLO % MAPPED WITH CLO**	**CLO & PLO MAPPED WITH GA**	**Cognitive Level CL**	**Knowledge Catogory KC**
CLO-1	use Matlab software tool and programming to find solution of various numerical problems.	**6[10] 7[10]**	**1,2,4, 5,10**	**An**	**C**
CLO-2	apply Matlab to determine solutions of linear system of equations.	**6[10] 7[10]**	**1,2,4, 5,10**	**An**	**F**
CLO-3	determine solution of nonlinear system of equations using Matlab and perform data analysis by fitting of curves using Matlab.	**6[10] 7[10]**	**1,2,4, 5,10**	**U**	**C, P**
CLO-4	calculate statistical variables using Matlab functions evaluate numerical integration of equally and non-equally spaced data using Matlab	**6[10] 7[10]**	**1,2,4, 5,10**	**R, C**	**F, P**
CLO-5	estimate derivatives of functions of first-order and higher using Matlab. solve ordinary differential equations using Matlab.	**6[10] 7[10]**	**1,2,4, 5,10**	**E**	**M**

Module	**Course Description**	**Hours**	**% CLO Mapping with Module**	**Learning Activitie**	**Assessment Tasks**	**Reference**
I BASIC MATLAB						
1.1	Creating Variables and Using Basic Arithmetic	1	1 [5]	Lec	MCQ	1
1.2	Standard Functions	1	1 [5]	PT	Ass	1
1.3	Vectors and Matrices	1	1 [10]	TPS	Ass	1
1.4	M-Files	0.5	1 [10]	Lec	Pro	1

1.5	The colon Notation and the for Loop	1	1 [5]	OO	Ass	1
1.6	The if Construct	1	1 [10]	Lec	Pro	1
1.7	The while Loop	1	1 [10]	GT	Pro	1
1.8	Simple Screen Output	0.5	1 [5]	PT	Qui	1
1.9	Keyboard Input	0.5	1 [5]	BS	MC Q	1
.10	User Defined Functions	1	1 [10]	Lec	Pro	1
.11	Basic Statistics	1	1 [10]	GT	Pro	1
.12	Plotting	1	1 [10]	Lec	Ass	1
1.13	Formatted Screen Output	0.5	1 [5]	BS	Qui	1
.14	File Input and Output (Formatted & Unformatted input & Output	1	1 [10]	GD	MP r	1
II SOLUTIONS TO LINEAR AND NONLINEAR EQUATIONS						
2.1	Linear Systems	1	2 [7]	Lec	MC Q	1,2
2.2	Gaussian Elimination	1	2 [10]	GT	Ass	1,2
2.3	Row Interchanges	0.5	2 [10]	PT	Qui	1,2
2.4	Partial Pivoting	0.5	2 [10]	SM	Pro	1,2
2.5	Multiple Right-Hand Sides	1	2 [7]	Lec	Pro	1,2
2.6	Singular Systems	1	2 [7]	Lec	Ass	1,2
2.7	Ill-Conditioned Systems	1	2 [7]	GD	Ass	1,2
2.8	Gauss–Seidel Iteration	1	2 [7]	Lec	Pro	1,2
2.9	Bisection Method	0.5	2 [7]	Lec	MC Q	1,2
.10	Finding an Interval containing a Root	0.5	2 [7]	PT	Pro	1,2
.11	Rule of False Position	1	2 [7]	OO	Ass	1,2
.12	The Secant Method	1	2 [7]	GT	Qui	1,2
.13	Newton's Method for Systems of Nonlinear Equations	1	2 [7]	Lec	Pro	1,2
.14	Higher Order Systems	1	2 [7]	GD	Ass	1,2
III CURVE FITTING AND STATISTICS						
3.1	Linear Interpolation	0.5	3[6]	Lec	MC Q	1,2
3.2	Differences	0.5	3[6]	CL	Ass	1,2
3.3	Polynomial Interpolation	1	3[6]	Lec	SA	1,2
3.4	Newton Interpolation	1	3[6]	EL	Pro	1,2
3.5	Neville Interpolation	0.5	3[6]	PT	Pro	1,2
3.6	Spline Interpolation	0.5	3[6]	EL	Pro	1,2
3.7	Least Squares Approximation	1	3[6]	Lec	Ass	1,2
3.8	Least Squares Straight Line Approximation	1	3[6]	EL	Pro	1,2
3.9	Least Squares Polynomial Approximation	1	3[6]	OO	Ass	1,2
.10	Statistical Terms	0.5	3[6]	Lec	MC Q	1,2
.11	Random Variable	0.5	3[6]	BS	Ass	1,2
.12	Frequency Distribution	0.5	3[6]	GT	Ass	1,2
.13	Expected Value, Average and Mean	0.5	3[6]	GT	Ass	1,2

3.14	Variance and Standard Deviation	1	3[6]	PT	Ass	1,2
3.15	Covariance and Correlation	1	3[6]	GD	Pro	1,2
3.16	Least Squares Analysis	1	3[6]	Lec	MCQ	1,2
3.17	Random Numbers	0.5	3[6]	BS	Qui	1,2
3.18	Generating Random Numbers	0.5	3[6]	BS	Qui	1,2
3.19	Random Number Generators	0.5	3[6]	TPS	Pro	1,2
3.20	Customising Random Numbers	0.5	3[6]	PT	Ass	1,2
3.21	Monte Carlo Integration	1	3[6]	EL	Pro	1,2
IV NUMERICAL INTEGRATION AND DIFFERENTIATION						
4.1	Analytic vs. Numerica Integration	0.5	4 [10]	Lec	MCQ	1,2
4.2	The Trapezium Rule (Again)	1	4 [10]	Lec	Pro	1,2
4.3	Simpson's Rule (Again)	1	4 [10]	PT	Pro	1,2
4.4	Higher Order Rules	1	4 [10]	EL	Pro	1,2
4.5	Gaussian Quadrature	1	4 [10]	EL	Pro	1,2
4.6	Numerical Differentiation: Two-Point Formula	0.5	4 [10]	Lec	Qui	1,2
4.7	Three- and Five-Point Formulae	0.5	4 [10]	GD	Qui	1,2
4.8	Higher Order Derivatives	1	4 [10]	OO	Pro	1,2
4.9	Error Analysis	1	4 [10]	BS	Pro	1,2
4.10	Cauchy's Theorem	1	4 [10]	Lec	SA	1,2
V ORDINARY DIFFERENTIAL EQUATIONS, EIGENVALUES AND EIGENVECTORS						
5.1	First-Order Equations	1	5 [7]	PT	Pro	1,2
5.2	Euler's Method	1	5 [7]	TPS	Pro	1,2
5.3	Runge–Kutta Methods	1	5 [7]	GD	Pro	1,2
5.4	Fourth-Order Runge–Kutta	1	5 [7]	SM	Qui	1,2
5.5	Systems of First-Order Equations	1	5 [7]	EL	Pro	1,2
5.6	Higher Order Equations	0.5	5 [7]	Lec	Qui	1,2
5.7	Boundary Value Problems	0.5	5 [7]	Lec	Qui	1,2
5.8	Shooting Method	1	5 [7]	GT	Pro	1,2
5.9	Difference Equations	1	5 [7]	OO	Pro	1,2
5.10	The Characteristic Polynomial	1	5 [7]	EL	Pro	1,2
5.11	The Power Method	1	5 [7]	TPS	Qui	1,2
5.12	Power Method, Theory	1	5 [7]	GD	Ass	1,2
5.13	Eigenvalues of Special Matrices	1	5 [7]	TPS	Ass	1,2
5.14	Eigenvalues, Diagonal Matrix	1	5 [3]	PT	Pro	1,2
5.15	Eigenvalues, Upper Triangular Matrix	1	5 [3]	GT	Ass	1,2
5.15	A Simple QR Method	1	5 [3]	OO	Pro	1,2

BOOKS FOR REFERENCE

1. C. Woodford, C. Phillips, *Numerical Methods with Worked Examples: Matlab Edition.* II Edn, Springer, London, 2012.
2. Won Young Yang, Wenwu Cao, Tae-Sang Chung, John Morris, *Applied Numerical Methods Using Matlab*, John Wiley & Sons, Inc., New Jersey, 2005.

3. Todd Young and Martin J. Mohlenkamp, *Raymond P. Canale, Introduction to Numerical Methods and Matlab Programming for Engineers*, Ohio University, Athens, 2020.
4. Jaan Kiusalaas, *Numerical Methods In Engineering With Matlab*, Cambridge University Press, UK, 2005.
5. Cleve B. Moler, *Numerical Computing with MATLAB*, SIAM, US, 2004
6. R2017a, *MATLAB Primer*, The MathWorks, Inc., US, 2017.

Course Title:	**NUMERICAL METHODS & MATLAB**	Course Type: **Practical IV**
		Course Code: **23PPP4**
Total Hours: **90**	Hours/Week: **6**	Credits: **4**
Pass-Out Policy : Minimum Contact Hours: 54 Total Score %: **100** Internal: **40** External: **60** Minimum Pass %: **50** [No Minimum for Internal]		
Course Creator:	**Expert 1:**	**Expert 2:**
Prof. A. Charles Hepzy Roy	**Dr. C. James**	**Dr. V. Anslin Ferby**
Asso. Prof., Faculty Head	Asso. Prof. of Physics	Asso. Prof. of Physics
+919944261881	**+919489500237**	**+919443595694**
achroy66@gmail.com	**james@scottchristian.org**	**anslinv@gmail.com**

CLO No.	Expected Course Learning Outcome *Upon completion of this course, the students will be able to ....*	PLO % MAPPED WITH CLO	CLO & PLO MAPPED WITH GA	Cognitive Level CL	Knowledge Catogory KC
CLO-1	numerical methods and implementation of these algorithms using the software package MATLAB.	**6[10] 7[10]**	**1,2,4, 5,10**	**An**	**P**
CLO-2	Write efficient, well-documented Matlab code and present numerical results in an informative way.	**6[10] 7[10]**	**1,2,4, 5,10**	**An**	**P**
CLO-3	The focus of this module is to do a quick introduction of most popular numerical methods in linear algebra, and use of MATLAB to solve practical problems.	**6[10] 7[10]**	**1,2,4, 5,10**	**U**	**P**
CLO-4	Helps to develop the mathematical skills of the students in the areas of numerical methods.	**6[10] 7[10]**	**1,2,4, 5,10**	**R, C**	**M**
CLO-5	Analyse and evaluate the accuracy of common numerical methods. Implement numerical methods in Matlab.	**6[10] 7[10]**	**1,2,4, 5,10**	**E**	**M**

No.	Course Description
1	**Plotting:**

	a) Plot a table of given data, with title, legends etc. b) Given table of refracting index and wavelength. Find the Cauchy's constants. c) Find the refractive index of the material for given wavelengths. d) Plot Gaussian function and find its parameters such as the height of the curve's peak the position of the centre of the peak and the standard deviation/Gaussian RMS width etc. e) Animate a Gaussian function by varying the sigma value.
2	**Roots of linear system – Gaussian methods:** a) Verify the given set of linear simultaneous equations are singular system. b) Perform partial pivoting. c) Check whether the given system is ill-conditioned. d) Solve the given set of linear simultaneous equations. e) Verify the answer with Gauss-Seidel Iteration method. f) Find the currents through the different arms of the Wheatstone's bridge.
3	**Roots of algebraic equations:** a) Find the root of an algebraic equation using bisection method with given error tolerance. b) Determine the root of the same equation using false position method. c) Calculate the root of the same equation using Secant Method. d) Solve it using Newton's Method. e) Compare the above methods with results and their errors. f) Estimate the radius of a molecule by solving van der Waals equation.
4	**Roots of nonlinear system of equations:** a) Use bisection method to find a root of the equation by determining an initial interval containing a root b) Modify the code for the bisection method to find the root of equation by Rule of False Position and compare the number of iterations with bisection method c) Obtain the root of equation using the Secant Method without an initial interval d) Determine the root of the equation using Newton–Raphson method e) Find solution to nonlinear system of equations using Newton's method
5	**Polynomial Interpolation:** a) Obtain the polynomial by interpolating the given table of data using Newton's interpolation method. b) Find the polynomial by interpolating the given table of data using Neville interpolation method. c) Determine the polynomial by interpolating the given table of data using Spline interpolation method. d) Find the altitude, velocity and acceleration profile of a rocket from the data received from the velocity probe in the rocket.

6	**Numerical Integration:** a) Integrate the given tabulated function using Trapezium rule b) Integrate the same tabulated function using Simpson's rule. c) Integrate a given function using Trapezium Rule. d) Integrate the same function using Simpson's Rule e) Integrate the same function using Monte Carlo Method by generating random numbers. f) Compare the three methods with the results and errors.
7	**Calculation of Statistical Terms:** a) Generate a sequence of random numbers using the multiplicative congruential generator b) Plot frequency distribution using Matlab statistical routines hist. (histogram), bar (bar chart) to find Expected Value and Average c) Find the mean and standard deviation of the sets of examination marks from the same group of students. d) Use Matlab statistical routines for to determine mean (mean), std. and cov. (covariance) for the marks obtained in a course e) Calculate the correlation coefficients for all possible pairings of marks obtained in three courses in a CIA test.
8	**Solution of Ordinary Differential Equations:** a) Solve the given first-order differential equation using Euler's method. b) Solve the same first-order differential equation using Runge-Kutta second order method. c) Solve the same first-order differential equation using Runge-Kutta fourth order method. d) Compare the methods with the results and errors. e) Obtain the radioactive profile of a given radioactive molecule. f) Find the quantity of radioactive material leftover at any point of time.
9	**Eigenvalue and Eigenvector:** a) Find the Eigen value and their corresponding Eigen vectors of the given square matrix using Power Method. b) Determine the Eigen value and their corresponding Eigen vectors of the given diagonal matrix using Power Method. c) Compute the Eigen value and their corresponding Eigen vectors of the given upper triangular matrix using Power Method. d) Estimate the Eigen value and their corresponding Eigen vectors of the given matrix using simple QR Method. e) Find the vibrational normal modes and their frequencies of a given molecule.

Course Title:	QUANTUM COMPUTATIONAL PHYSICS	Course Type: **Theory**
		Course Code: **23PPEF**
Total Hours: **90**	Hours/Week: **6**	Credits: **4**
Pass-Out Policy : Minimum Contact Hours: 54 Total Score %: **100** Internal: **40** External: **60** Minimum Pass %: **50** [No Minimum for Internal]		

Course Creator:	**Expert 1:**	**Expert 2:**
Prof. A. Charles Hepzy Roy	**Dr. C. James**	**Dr. D.Hudson Oliver**
Asso. Prof., Faculty Head	Asso. Prof. of Physics	Assi. Prof. of Physics
+919944261881	**+919489500237**	+919952654515
achroy66@gmail.com	**james@scottchristian.org**	hudson2612@gmail.com

CLO No.	Expected Course Learning Outcome *Upon completion of this course, the students will be able to ....*	PLO % MAPPED WITH CLO	CLO & PLO MAPPED WITH GA	Cognitive Level CL	Knowledge Catogory KC
CLO- 1	Mastery of GPT-Prompting: Students will become proficient in leveraging GPT-Prompting for formulating and solving complex problems in quantum mechanics and other physics domains.	**6[10] 10[10]**	**1,2, 3,5, 7,9,10**	**An**	**F, C**
CLO- 2	Programming Proficiency: Develop strong programming skills in Python and MATLAB, enabling students to implement and optimize solutions to real-world physics challenges	**6[10] 10[10]**	**1,2, 3,5, 7,9,10**	**An**	**C, P**
CLO- 3	Quantum Problem-Solving: Gain a deep understanding of quantum mechanics and apply computational methods to solve intricate quantum problems using GPT-based approaches	**6[10] 10[10]**	**1,2, 3,5, 7,9,10**	**U**	**F, P**
CLO- 4	Integration Skills: Learn how to seamlessly integrate GPT-Prompting with Python and MATLAB for enhanced problem-solving capabilities in various physics applications	**6[10] 10[10]**	**1,2, 3,5, 7,9,10**	**R, C**	**M**
CLO-5	Critical Thinking and Communication: Foster critical thinking skills and the ability to communicate effectively, both in code and through clear explanations of physics concepts	**6[10] 10[10]**	**1,2, 3,5, 7,9,10**	**E**	**P, M**

	and computational solutions				

Module	Course Description	Hours	% CLO Mapping with Module	Learning Activitie	Assessment Tasks	Reference
I	**INTRODUCTION TO QUANTUM COMPUTING AND GPT-PROMPTING**					
1.1	Quantum Computing Fundamentals	1	1[10]	Lec	SA	1
1.2	Introduction to GPT-Prompting in Physics	1	1[10]	Lec	Ess	3
1.3	Setting up Python and MATLAB for Quantum Computing	1	1[10]	GD	SA	4
1.4	Basic GPT-Prompting Commands	1	1[10]	GD	Pro	1
1.5	Quantum Mechanics Overview	1	1[10]	TPS	Sem	1
1.6	GPT Interaction with Python and MATLAB	2	1[10]	Lec	SA	4
1.7	Quantum Problem Formulation	1	1[10]	Lec	Sem	1
1.8	Troubleshooting and Debugging	1	1[10]	Lec	Qui	1
1.9	Quantum Prompting Workflow	1	1[10]	Lec	Pro	1
.10	Quantum Prompting Best Practices	1	1[10]	GD	Pro	1
II	**QUANTUM STATE REPRESENTATIONS AND OPERATORS**					
2.1	Quantum States and Dirac Notation	1	2[10]	Lec	SA	1
2.2	Hermitian Operators and Observables	1	2[10]	Lec	Ess	1
2.3	Matrix Representations in Python and MATLAB	2	2[10]	GD	SA	4
2.4	Quantum Gates and Circuits	1	2[10]	GD	Pro	1
2.5	Quantum Superposition and Entanglement	1	2[10]	TPS	Sem	1
2.6	Quantum State Evolution	1	2[10]	Lec	SA	1
2.7	Expectation Values and Measurements	1	2[10]	Lec	Sem	1
2.8	Quantum Noise and Decoherence	1	2[10]	Lec	Qui	1
2.9	Quantum Information Theory Basics	1	2[10]	Lec	Pro	1
.10	Problem Solving: Manipulating Quantum States	1	2[10]	GD	Pro	1
III	**ADVANCED QUANTUM ALGORITHMS AND SIMULATIONS**					
3.1	Grover's Algorithm and Search Problems	1	3[10]	Lec	SA	2
3.2	Shor's Algorithm for Integer Factorization	1	3[10]	Lec	Ess	2
3.3	Quantum Fourier Transform	1	3[10]	GD	SA	2
3.4	Variational Quantum Eigensolvers	1	3[10]	GD	Pro	2
3.5	Quantum Machine Learning Applications	1	3[10]	TPS	Sem	2
3.6	Quantum Walks and Quantum Cellular Automata	1	3[10]	Lec	SA	2
3.7	Quantum Chemistry Simulations	1	3[10]	Lec	Sem	2
3.8	Quantum Simulations with Python and MATLAB	2	3[10]	Lec	Qui	4
3.9	Quantum Error Correction Techniques	1	3[10]	Lec	Pro	2
.10	Problem Solving: Implementing Quantum Algorithms	1	3[10]	GD	Pro	2
IV	**APPLICATIONS IN COMPUTATIONAL PHYSICS**					

4.1	Quantum Cryptography and Secure Communication	1	4[10]	Lec	Ess	2
4.2	Quantum Teleportation and Communication	1	4[10]	GD	SA	2
4.3	Quantum Sensing and Metrology	1	4[10]	GD	Pro	2
4.4	Quantum Computing in Materials Science	1	4[10]	TPS	Sem	2
4.5	Quantum Computing in Astrophysics	1	4[10]	Lec	SA	2
4.6	Quantum Computing in High-Energy Physics	2	4[10]	Lec	Sem	2
4.7	Quantum Computing in Climate Modeling	1	4[10]	Lec	Qui	2
4.8	Quantum Computing in Biological Systems	1	4[10]	Lec	Pro	2
4.9	Quantum Computing in Finance	1	4[10]	GD	Pro	2
.10	Problem Solving: Real-world Quantum Applications	1	4[10]	Lec	SA	2
V	**CAPSTONE PROJECT AND INTEGRATION**					
5.1	Project Planning and Proposal	1	5[10]	Lec	SA	3
5.2	GPT-Prompting Integration with Quantum Simulations	2	5[10]	Lec	Ess	3
5.3	Advanced Visualization Techniques	1	5[10]	GD	SA	3
5.4	Analyzing and Interpreting Results	1	5[10]	GD	Pro	3
5.5	Optimizing Quantum Prompting Model	1	5[10]	TPS	Sem	3
5.6	Code Integration: GPT-Prompting and Quantum Algorithms	2	5[10]	Lec	SA	3
5.7	Ethical Considerations in Quantum Prompting	2	5[10]	Lec	Sem	3
5.8	Collaborative Quantum Prompting Projects	2	5[10]	Lec	Qui	3
5.9	Presenting Findings and Project Documentation	2	5[10]	Lec	Pro	3
5.10	Future Trends in Quantum Prompting and Physics	2	5[10]	GD	Pro	3

BOOKS FOR REFERENCE

1. Preskill, J, *Quantum Computing in the NISQ era and beyond*, Quautum, 2018.
2. Nielsen, M. A., & Chuang, I. L. *Quantum Computation and Quantum Information*, Cambridge, New York, 2010.
3. OpenAI GPT API Documentation.
4. Python Documentation and Tutorials.
5. MATLAB Documentation and Tutorials.

Course Title:	**ADVANCED OPTICS**	Course Type: **Theory**
		Course Code: **23PPEG**
Total Hours: **90**	Hours/Week: **6**	Credits: **4**
Pass-Out Policy : Minimum Contact Hours: 54 Total Score %: **100** Internal: **40** External: **60** Minimum Pass %: **50** [No Minimum for Internal]		

Course Creator:	**Expert 1:**	**Expert 2:**
Prof. A. Charles Hepzy Roy	**Dr.D.Hudson Oliver**	**Dr. C. James**
Asso. Prof., Faculty Head	Assi. Prof. of Physics	Asso. Prof. of Physics
+919944261881	**+919952654515**	**+919489500237**
achroy66@gmail.com	**hudsonoliver@scottchristian.org**	**james@scottchristian.org**

CLO No.	**Expected Course Learning Outcome** *Upon completion of this course, the students will be able to:*	**PLO % MAPPED WITH CLO**	**CLO & PLO MAPPED WITH GA**	**Cognitive Level CL**	**Knowledge Catogory KC**
CLO - 1	Apply the concepts of polarization and double refraction	**8[20]**	**1,3,5, 7,8,9**	**An**	**C**
CLO - 2	Analyse the working of different types of lasers	**8[20]**	**1,3,5, 7,8,9**	**An**	**C, F**
CLO - 3	Impart an extensive understanding of fiber optics	**8[20]**	**1,3,5, 7,8,9**	**U**	**F, P**
CLO - 4	differentiate first and second harmonic generation in non-linear optics	**8[20]**	**1,3,5, 7,8,9**	**U, C**	**P**
CLO -5	Apply the principles of magneto-optic and electro-optic effects	**8[20]**	**1,3,5, 7,8,9**	**E**	**P, M**

Module	**Course Description**	**Hours**	**% CLO Mapping with Module**	**Learning Activitie**	**Assessment Tasks**	**Reference**
I	**POLARIZATION AND DOUBLE REFRACTION**					
1.1	Classification of polarization - Transverse character of light waves	1	1[10]	TPS	Qui	1
1.2	Polarizer and analyser – Malus' law	1	1[8]	Lec	SA	
1.3	Production of polarized light	1	1[8]	Lec	Ess	1
1.4	Wire grid polarizer and the polaroid	1	1[8]	GD	SA	1
1.5	Polarization by reflection	1	1[8]	GD	Sem	1

1.6	Polarization by double refraction	1	1[10]	TPS	Pro	1
1.7	Polarization by scattering	1	1[8]	Lec	SA	1
1.8	The phenomenon of double refraction	1	1[8]	Lec	Sem	1
1.9	Normal and oblique incidence	1	1[7]	Lec	Qui	1
1.10	Interference of polarized light: Quarter and half wave plates	1	1[9]	Lec	Pro	1
1.11	Analysis of polarized light	1	1[8]	GD	Pro	1
1.12	Optical activity	1	1[8]	TPS	Pro	1
II	**LASERS**					
2.1	Basic principles	1	2[9]	TPS	Qui	2
2.2	Spontaneous and stimulated emissions	1	2[9]	Lec	Ess	2
2.3	Components of the laser	1	2[9]	CL	Ess	2
2.4	Resonator and lasing action	1	2[10]	CL	Ess	2
2.5	Types of lasers and its applications	2	2[9]	Lec	SA	2
2.6	Solid state lasers – Ruby laser	1	2[9]	CL	Ass	2
2.7	Nd:YAG laser	1	2[9]	GD	Ess	2
2.8	gas lasers – He-Ne laser	1	2[9]	GD	SA	2
2.9	CO_2 laser	1	2[9]	GD	Sem	2
2.10	Chemical lasers – HCl laser	1	2[9]	TPS	Pro	2
2.11	Semiconductor laser	1	2[9]	Lec	SA	2
III	**FIBRE OPTICS**					
3.1	Introduction – Total internal reflection	1	3[8]	Lec	Qui	3
3.2	The optical fiber	1	3[8]	PT	SA	3
3.3	Glass fibers	1	3[8]	TPS	Pro	3
3.4	The coherent bundle	1	3[8]	GD	SA	3
3.5	The numerical aperture	1	3[8]	Lec	Sem	3
3.6	Attenuation in optical fibers	1	3[10]	Lec	SA	3
3.7	Single and multi-mode fibers	1	3[10]	CL	Ess	3
3.8	Pulse dispersion in multimode optical fibers	1	3[10]	Lec	SA	3
3.9	Ray dispersion in multimode step index fibers	1	3[10]	GD	SA	3
3.10	Parabolic- index fibers	1	3[7]	Lec	Pro	3
3.11	Fiber-optic sensors: precision displacement sensor	1	3[6]	Lec	SA	3
3.12	Precision vibration sensor	1	3[7]	GD	Sem	3
IV	**NON-LINEAR OPTICS**					
4.1	Basic principles	1	4[12]	Lec	MCQ	2
4.2	Harmonic generation	2	4[13]	GD	Ess	2
4.3	Second harmonic generation	2	4[13]	CL	SA	2
4.4	Phase matching	1	4[12]	Lec	Sem	2
4.5	Third harmonic generation	2	4[13]	GD	Ess	2
4.6	Optical mixing	1	4[12]	Lec	Ess	2

4.7	Parametric generation of light	1	4[13]	Lec	Sem	2
4.8	Self-focusing of light	1	4[12]	CL	Ass	2
V	**MAGNETO - OPTICS AND ELECTRO - OPTICS**					
5.1	Magneto-optical effects	1	5[7]	Lec	Qui	1
5.2	Zeeman effect	1	5[8]	Lec	SA	1
5.3	Inverse Zeeman effect	1	5[8]	GD	Ess	1
5.4	Faraday effect	1	5[8]	CL	Ess	1
5.5	Voigt effect	1	5[7]	Lec	Sem	1
5.6	Cotton-mouton effect	1	5[8]	BS	MCQ	1
5.7	Kerr magneto- optic effect	1	5[7]	Lec	SA	1
5.8	Electro-optical effects	1	5[8]	Lec	SA	1
5.9	Stark effect	1	5[8]	BS	MCQ	1
5.10	Inverse stark effect	1	5[8]	Lec	Ess	1
5.11	Electric double refraction	1	5[8]	CL	Sem	1
5.12	Kerr electro-optic effect	1	5[7]	CL	Ess	1
5.13	Pockels electro- optic effect	1	5[8]	Lec	Sem	1

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Course Title: **QUANTUM COMPUTATIONAL PHYSICS**		Course Type: **Practical**
		Course Code:
Total Hours: **90**	Hours/Week: **6**	Credits: **4**
Pass-Out Policy : Minimum Contact Hours: 54 Total Score %: **100** Internal: **40** External: **60** Minimum Pass %: **50** [No Minimum for Internal]		
Course Creator:	**Expert 1:**	**Expert 1:**
Prof. A. Charles Hepzy Roy	**Dr. C. James**	**Dr.D. Hudson Oliver**
Asso. Prof., Faculty Head	Asso. Prof. of Physics	Assi. Prof. of Physics

+919944261881	**+919489500237**	**+919952654515**
achroy66@gmail.com	**james@scottchristian.org**	**hudsonoliver@scottchristian.org**

CLO No.	Expected Course Learning Outcome *Upon completion of this course, the students will be able to:*	PLO % MAPPED WITH CLO	CLO & PLO MAPPED WITH GA	Cognitive Level CL	Knowledge Catogory KC
CLO-1	Students will learn the basics of Computational Physics and numerical methods	**6[10] 10[10]**	**1,3,5, 7,9**	**An**	**P**
CLO-2	Using Matrix calculations to solve problems like, Fourier series and related problems	**6[10] 10[10]**	**1,3,5, 7,9**	**An**	**P**
CLO-3	Students are expected to perform & learn computation of data by using different numerical methods, solving boundary value problem	**6[10] 10[10]**	**1,3,5, 7,9**	**U**	**F, P**
CLO-4	Able to solve problems with Fourier transform, solution of ODE and PDE	**6[10] 10[10]**	**1,3,5, 7,9**	**U, C**	**P**
CLO-5	Students will learn the simulation methods like Monte Carlo method and Molecular Dynamics, introduction to Parallel computing and Quantum computing	**6[10] 10[10]**	**1,3,5, 7,9**	**E**	**P, M**

(Perform any two from each module from the following list of experiments)

No	Course Description
1	GPT Interaction with Python and MATLAB: a) Interact with the GPT (like GPT-3) API and its capabilities through a simple Python script by sending prompts and receiving responses. b) Create a program that sends user input to GPT and retrieves and displays the generated text. c) GPT integration in MATLAB by using its Python interoperability. Run Python scripts within MATLAB to interact with the GPT API. d) Create a task where GPT assists in automating a process in either Python or MATLAB. For instance, generating code snippets, writing reports, or assisting in data analysis. e) Configure Python and MATLAB environments for quantum computing tasks and utilize GPT for problem-solving assistance.
2	Quantum State Representations and Operators: a) Simulate the creation and manipulation of quantum states using Dirac notation. Use GPT, Python, and MATLAB to perform calculations and visualize the quantum states. b) Simulate the measurement of quantum observables represented by

	Hermitian operators using GPT, Python, and MATLAB. c) Develop matrix representations for quantum operators using Python and MATLAB. Apply these representations to solve a real physics problem related to a quantum system (one-dimensional quantum harmonic oscillator). d) Simulate quantum measurements on various quantum states and calculate their corresponding expectation values using GPT, Python, and MATLAB. e) Solve the time-independent Schrödinger equation for a quantum harmonic oscillator potential. Use Python or MATLAB to implement the creation and annihilation operators to find the energy eigenstates and corresponding eigenvalues for the harmonic oscillator potential.
3	Advanced Quantum Algorithms and Simulations: a) Implement Grover's Algorithm to solve a search problem using GPT, Python, and MATLAB. Understand the quantum search process and evaluate its efficiency compared to classical search algorithms. b) Simulate Shor's Algorithm to factorize a given composite number into its prime factors using GPT, Python, and MATLAB. c) Simulate and analyze the Quantum Fourier Transform on a quantum state. Use GPT, Python, and MATLAB to implement the QFT algorithm and explore its applications. d) Simulate the electronic structure of a molecular system, such as H_2, using quantum algorithms and analyze key properties. Use GPT, Python, and MATLAB. e) Simulate and analyze quantum walks and quantum cellular automata using GPT, Python, and MATLAB. Explore the quantum algorithms and computational simulations related to these topics.
4	Applications in Computational Physics: a) Simulate a basic Quantum Key Distribution protocol to understand the principles of secure communication using quantum principles. Implement the protocol using GPT, Python, and MATLAB. b) Implement quantum algorithms to simulate the electronic structure of a material using GPT, Python, and MATLAB. Explore the advantages of quantum computing in tackling materials science problems. c) Simulate the quantum entanglement of particles in a many-body astrophysical system using quantum computing concepts. Utilize GPT, Python, and MATLAB to implement quantum algorithms for the simulation. d) Apply quantum computing techniques to simulate and analyze a scenario in high-energy physics. Use GPT, Python, and MATLAB to

	implement quantum algorithms and visualize the results. e) Implement a quantum algorithm to simulate a simplified climate modeling problem. Use GPT for guidance, Python for quantum programming, and MATLAB for visualization.
5	GPT-Prompting to guide and enhance quantum simulations. a) Use GPT to generate a problem statement and prompt for simulating the time evolution of a quantum spin system. Formulate the problem in natural language, including the system size, coupling strength, and initial conditions. b) Implement a quantum simulation of the Heisenberg spin chain using Python and a suitable quantum simulation library (e.g., Qiskit or QuTiP). Use GPT-prompting to guide the choice of parameters (e.g., system size, time steps). c) Replicate the quantum simulation in MATLAB using appropriate functions and visualization tools. Compare the results obtained from Python and MATLAB implementations. d) Analyze the time evolution of spin correlations and magnetization in the quantum spin system. Visualize the results using matplotlib in Python and built-in plotting functions in MATLAB. e) Use GPT to generate prompts for analyzing specific aspects of the quantum simulation results (e.g., the impact of changing the coupling strength, observing quantum entanglement).

Course Title:	**MATERIAL SCIENCE**	Course Type: **Theory**
		Course Code: **23PPEH**
Total Hours: **90**	Hours/Week: **6**	Credits: **4**
Pass-Out Policy : Minimum Contact Hours: 54 Total Score %: **100** Internal: **40** External: **60** Minimum Pass %: **50** [No Minimum for Internal]		
Course Creator:	**Expert 1:**	**Expert 1:**
Prof. A. Charles Hepzy Roy	**Dr. H. Adlin Mahiba**	**Dr. D. Hudson Oliver**
Asso. Prof., Faculty Head	**Assi. Prof. of Physics**	Assi. Prof. of Physics
+919944261881	**+919486578077**	**+919952654515**
achroy66@gmail.com	**adlinemahiba1@gmail.com**	**hudson2612@gmail.com**

CLO - No.	**Course Learning Outcome** ***Upon completion of this course, students will be able to:***	**PLO % MAPPED WITH CLO**	**CLO & PLO MAPPED WITH GA**	**Cognitive Level CL**	**Knowledge Catogory KC**
CLO-1	Acquire knowledge on optoelectronic materials	**3[10]** **4[10]**	**1,2,3,** **5,6,7**	**R**	**C**

CLO-2	Be able to prepare ceramic materials	**3[10] 4[10]**	**1,2,3, 5,6,7**	**Ap**	**F**
CLO-3	Be able to understand the processing and applications of polymeric materials	**3[10] 4[10]**	**1,2,3, 5,6,7**	**U, Ap**	**F, P**
CLO-4	Be aware of the fabrication of composite materials	**3[10] 4[10]**	**1,2,3, 5,6,7**	**E**	**P**
CLO-5	Be knowledgeable of shape memory alloys, metallic glasses and nanomaterials	**3[10] 4[10]**	**1,2,3, 5,6,7**	**R**	**M**

Module	**Course Description**	**Hours**	**% CLO Mapping with Module**	**Learning Activitie**	**Assessment Tasks**	**Reference**
I	**OPTOELECTRONIC MATERIALS**					
1.1	Importance of optical materials – properties:	1	1[10]	Lec	SA	1
1.2	Band gap and lattice matching	1	1[10]	Lec	SA	1
1.3	Optical absorption and emission	1	1[10]	GD	MCQ	1
1.4	Charge injection, quasi-Fermi levels and recombination	1	1[10]	Lec	SA	1
1.5	Optical absorption, loss and gain	1	1[10]	GD	Ess	1
1.6	Optical processes in quantum structures	1	1[10]	Lec	Ess	1
1.7	Inter-band and intra-band transitions	1	1[10]	Lec	Ess	1
1.8	Organic semiconductors	1	1[10]	Lec	SA	1
1.9	Light propagation in materials – Electro-optic effect and modulation	1	1[10]	GD	Qui	1
1.10	Electro-absorption modulation – exciton quenching.	1	1[10]	Lec	Qui	1
II	**CERAMIC MATERIALS**					
2.1	Ceramic processing	1	2[15]	Lec	Ess	5
2.2	Powder processing	2	2[10]	Lec	Ess	5
2.3	Milling and sintering	2	2[10]	Lec	SA	5
2.4	Structural ceramics	1	2[10]	GD	MCQ	5
2.5	Zirconia, almina	1	2[10]	GD	SA	5
2.6	Silicon carbide, tungsten carbide	1	2[10]	GD	SA	5

2.7	Electronic ceramics	1	2[10]	Lec	SA	5
2.8	Refractories	1	2[10]	Lec	SA	5
2.9	Glass and glass ceramics	1	2[15]	Lec	Ess	5
III	**POLYMERIC MATERIALS**					
3.1	Polymers and copolymers	1	3[10]	Lec	Ess	5
3.2	Molecular weight measurement	1	3[10]	Lec	Ess	5
3.3	Synthesis: chain growth polymerization	1	3[10]	Lec	Ess	5
3.4	Polymerization techniques	1	3[10]	GD	Ass	5
3.5	Glass transition temperature and its measurement	1	3[10]	GD	SA	5
3.6	Viscoelasticity	1	3[10]	GD	SA	5
3.7	Polymer processing techniques	1	3[10]	Lec	Ass	5
3.8	Applications: conducting polymers	1	3[10]	Lec	Ass	5
3.9	Biopolymers	1	3[10]	Lec	Ess	5
3.10	High temperature polymers	1	3[10]	Lec	Ass	5
IV	**COMPOSITE MATERIALS**					
4.1	Particle reinforced composites	1	4[15]	Lec	Sem	2,4
4.2	Fiber reinforced composites	1	4[15]	Lec	Sem	2,4
4.3	Mechanical behaviour	1	4[10]	GD	Sem	2,4
4.4	Fabrication methods of polymer matrix composites	2	4[15]	Lec	Ass	2,4
4.5	Fabrication methods of metal matrix composites	2	4[15]	Lec	Ass	2,4
4.6	Carbon/carbon composites	1	4[10]	Lec	SA	2,4
4.7	Fabrication	1	4[10]	Lec	Sem	2,4
4.8	Applications	1	4[10]	GD	Sem	2,4
V	**NEW MATERIALS**					

5.1	Shape memory alloys	1	5[10]	Lec	Sem	3
5.2	Mechanisms of one-way and two-way shape memory effect, reverse transformation	1	5[10]	Lec	Ess	3
5.3	Thermo-elasticity and pseudo-elasticity	1	5[10]	Lec	SA	3
5.4	Examples and applications	1	5[10]	GD	MCQ	3
5.5	Bulk metallic glass, criteria for glass formation and stability	2	5[10]	GD	Sem	3
5.6	Examples and mechanical behaviour	1	5[10]	Lec	Ass	3
5.7	Nanomaterials: classification	1	5[10]	Lec	Ass	3
5.8	Size effect on structural and functional properties	1	5[10]	GD	Sem	3
5.9	Processing and properties of Nano crystalline materials	1	5[10]	Lec	Sem	3
5.10	Single walled and multi walled carbon nanotubes	1	5[10]	Lec	Ass	3

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1. Jasprit Singh, Electronic and optoelectronic properties of semiconductor structures, Cambridge University Press, 2007
2. P. K. Mallick. Fiber-Reinforced Composites. CRC Press, 2008.
3. V. Raghavan, 2003, Materials Science and Engineering, 4th Edition, Prentice- Hall India, New Delhi(For units 2,3,4 and 5),
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9. https://nptel.ac.in/courses/113/105/113105025/
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Course Title:	**MEDICINAL CHEMISTRY**	Course Type: **Theory**
		Course Code: **23PCN1**
Total Hours: **90**	Hours/Week: **6**	Credits: **4**

Pass-Out Policy :
Minimum Contact Hours: 54
Total Score %: **100** Internal: **40** External: **60**
Minimum Pass %: **50** [No Minimum for Internal]

Course Creator:	**Expert 1:**	**Expert 2:**
Dr. Ragel Mabel Saroja	**Dr. A. Jeena Pearl**	**Dr. A. Yardily**
Asso. Prpf., Faculty Head	**Assi. Prof.**	**Assi. Prof.**
+919442303508	**+919487352164**	**+91948711332**
ragelmabelsaroja@yahoo.co.in	jeenapearl@rediffmail.com	ayardily@gmail.com

CLO - No.	**Course Learning Outcome** ***Upon completion of this course, students will be able to:***	PLO % MAPPED WITH CLO	CLO & PLO MAPPED WITH GA	Cognitive Level CL	Knowledge Catogory KC
CLO-1	Define drug and know drug discovery and design Know the QSAR, Hammett equation Craig	**3[10] 4[10]**	**1,2,3, 5,6,7**	**R**	**C**
CLO-2	Illustrates the routes, distribution, metabolism and dosing of drug	**3[10] 4[10]**	**1,2,3, 5,6,7**	**U**	**F**
CLO-3	Explain some of the medicinally important compounds, sulphonamides and the action of anesthetics	**3[20] 4[10]**	**1,2,3, 5,6,7**	**Ap**	**P**
CLO-4	Understand the classification, structure and synthesis of antineoplastic agents and antimalarial drugs	**3[10] 4[10]**	**1,2,3, 5,6,7**	**An**	**P**
CLO-5	Know the structure and synthesis of antibiotics and analgesic	**3[10] 4[10]**	**1,2,3, 5,6,7**	**E**	**M**

Module	**Course Description**	**Hours**	**% CLO Mapping with Module**	**Learning Activitie**	**Assessment Tasks**	**Reference**
I	**DRUG DISCOVERY AND DESIGN**					
1.1	Drug – definition, requirements of an ideal drug.	1	1[10]	Lec	Qui	1
1.2	Drug discovery of Penicillin	1	1[10]	Lec	Mcq	2
1.3	Discovery of lead compounds, Natural sources, Analogues and prodrugs	2	1[20]	Lec	Sem	1
1.4	Concepts of lead molecules with example Factors governing drug design.	2	1[10]	TPS	Ass	2
1.5	The method of variation - drug design through disjunction, conjunction	1	1[10]	BS	Ass	3

1.6	Hammett equation, Taft equation	2	1[10]	Lec	Quiz	2
1.7	Hansch equation, QSAR, Craig plot	2	1[20]	TPS	Ass	2
1.8	Computer – Assisted design.	1	1[10]	GD	Ass	3
II	**PHARMACOKINETICS**					
2.1	Pharmacokinetics (ADME) – Introduction	1	2[10]	Lec	Qui	4
2.2	Routes of administration of drugs	2	2[10]	Lec	Qui	4
2.3	Oral administration of drugs	1	2[10]	BS	Sem	4
2.4	Administration of drugs through injection	1	2[10]	TPS	Ass	4
2.5	Drug absorption – oral routes.	1	2[10]	Lec	Mcq	1
2.6	Drug distribution to tissues, cells, blood – brain barrier, placental barrier	2	2[20]	Lec	Qui	1
2.7	Drug Metabolism –Phase I transformation, Phase II transformation.	2	2[10]	TPS	Ass	2
2.8	Drug excretion through lungs, bile duct and kidneys	1	2[10]	Lec	Sem	2
2.9	Drug dosing – drug half – life, steady state concentration and drug tolerance	1	2[10]	BS	Ass	2
III	**ANTIMALARIAL ,ANAESTHETIC AND SULPHA DRUGS**					
3.1	Antimalarial drugs-introduction and classification	2	3[20]	Lec	Qui	3
3.2	Structure and synthesis of chloroquine, primaquine. proguanil. pyrimethamine, camoquine, novacaine, methylisoquine and pamaquine	3	3[20]	Lec	Sem	3
3.3	Structure and uses of Narcotic drugs -Morphine, Non-Narcotic drugs -Ibuprofen	2	3[20]	BS	Ass	3
3.4	Preparation and uses of local Anaesthetic s-chloroform, cocaine	2	3[20]	Lec	Mcq	3
3.5	Chemistry of sulphonamides – sulfothiazole Sulphadiazine, Prontosil – Preparation and uses	3	3[20]	Lec	Sem	3
IV	**CHEMOTHERAPEUTIC AGENT**					
4.1	Antineoplastic agents Introduction	2	4[10]	Lec	Qui	4
4.2	Classification	2	4[20]	Lec	Sem	4
4.3	Structure and synthesis of cyclophosphamide, Ifosfamide, Chlorambucil, Busulfan	3	4[20]	Lec	Sem	4
4.4	Structure and synthesis of Decarbazine, Fluorouracil, Cisplatin and Carboplatin	2	4[20]	TPS	Mcq	4
4.5	Cancer Chemotherapy	3	4[20]	TPS	Ass	4

V	ANALGESICS, ANTIBIOTICS AND ANTI DIABETIC DRUGS					
5.1	Antidiabetic Agents :Introduction, Types of diabetics, Drugs used for the treatment, chemical classification	2	5[20]	Lec	Sem	4
5.2	Mechanism of action, Treatment of diabetic mellitus, Chemistry of insulin	2	5[20]	Lec	Qui	4
5.3	Antibiotics –Introduction Synthesis of Penicillin, Cephalosporin, Streptomycin,Terramycin ,	3	3[20]	Lec	Sem	4
5.4	Analgesics-Introduction, Classification	2	5[20]	BS	Qui	4
5.5	Structure of Aspirin, Salol, Antifebrin, Phenacetin, Novalgin, Cinchophen	3	5[20]	Lec	Sem	4

BOOKS FOR REFERENCE:

1. Graham L. Patrick, Introduction to Medicinal Chemistry, Oxford University press 1995.
2. Graham L. Patrick, Instant notes on Medicinal Chemistry, Series Edn. B. P. Hawes Viva book, (P) Ltd. 2002
3. G, C.D. Krupadanam, D. Vijaya Prasad, K.V. Rao, K.L.N. Reddy and C. Sudhakar, Drug, university presses India Ltd. 2001.
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9. P.Parimoo, A Text book of Medical Chemistry, Newdelhi, CBS Publishers, 1995
10. Foye"s Princles of Medicinal Chemistry, Lipincott Williams, Seventh Edition, 2012