UNIVERSITY OF KERALA

Four Year Under Graduate Programme

(UoK FYUGP)

Syllabus

Major Discipline: PHYSICS

University of Kerala

Senate House Campus, Palayam, Thiruvananthapuram- 34, Kerala, India

May 2024

CONTENTS

1. BOARD OF STUDIES

1. Dr. Prabitha V. G., Govt. College for Women, Thiruvananthapuram, (Chairperson)
2. Dr. P.R. Biju, Mahatma Gandhi University, Kottayam, (Expert)
3. Dr. Bijini B. R., VTMNSS College, Dhanuvachapuram, (Member)
4. Dr. Hysen Thomas, Christian College, Chengannoor, (Member)
5. Dr. Anilkumar K. M., M.S.M College, Kayamkulam, (Member)
6. Dr. Sajesh Sasidharan, Sree Narayana College, Sivagiri, Varkala, (Member)
7. Mr. Viji V. R., University College, Thiruvananthapuram, (Member)
8. Dr. Renju R. Krishnan, St. Xavier's College, Thumba, (Member)
9. Dr. Vikas L. S., Govt. Arts College, Thiruvananthapuram, (Member)
10. Dr. Sibi K. S., University of Kerala, Kariavattom, Thiruvananthapuram, (Member)

2. CONTRIBUTORS

1. Dr. J. Binoy. Govt. College for Women, Thiruvananthapuram, (Academic Council Member)
2. Dr. Prince P. R., University College, Thiruvananthapuram, (Faculty)
3. Dr. Padma Kumar H., Mahatma Gandhi College, Thiruvananthapuram, (Faculty)
4. Prof. N.V Unnikrishnan, School of Pure and Applied Physics, M G University (Subject Expert)
5. Dr. N. Shaji, Department of physics, CUSAT, (Subject Expert)
6. Dr. Abhilash Kumar R G, Govt. College Ambalappuzha , (Subject Expert)
7. Sri. Muhammed Rishad K P, International School of Photonics, CUSAT, (Subject Expert)
8. Dr. Rajeshmon V. G., St. Paul's College, Kalamassery , (Subject Expert)
9. Dr. Anjana P.S., All Saint's College, Thiruvananthapuram
10. Dr. D. Sajan, Bishop Moore College, Mavelikkara
11. Mr. Srijith S., Sree Narayana College, Kollam
12. Mrs. Biji M. S., Govt. Arts College, Thiruvananthapuram
13. Mr. Syam Kumar S. U., N.S.S. College, Nilamel
14. Dr. Deepa V., Mahatma Gandhi College, Thiruvananthapuram
15. Dr. Mahesh S K, N. S. S. College, Pandalam
16. Miss. Devi R. Nair, University College, Thiruvananthapuram
17. Dr. Veena Suresh Babu , All Saints' College, Thiruvananthapuram
18. Mrs. Gayathri V., Shree Vidhyadhiraja College of Arts & Science, Karunagappally
19. Dr. Rajesh S R, S D College, Alappuzha

20. Dr. Rajesh S, Mar Ivanios College (Autonomous), Thiruvananthapuram
21. Dr. Arun Aravind, Bishop Moore College, Mavelikkara
22. Dr. Veena Gopal S., Christ Nagar College , Maranalloor
23. Dr. Sasanka Kumar S., T.K.M.M. college Nangiarkulangara, Harippad
24. Dr. Malu Somaraj, Sree Narayana College, Cherthala
25. Dr. Mohammed Salim M., T.K.M. College of Arts and Science, Kollam
26. Dr. Morris Marieli Antoinette, St. Joseph's College for Women, Alappuzha
27. Dr. Krishnakumar K., S.G. College, Kottarkkara
28. Dr. Anshad A., T.K.M. College of Arts and Science, Kollam
29. Dr. Sachin P C, Fathima Matha National College (Autonomous), Kollam
30. Dr. Indulal, S.G. College, Kottarakkara
31. Dr. Nisha N G, Govt. College for Women, Thiruvananthapuram
32. Dr. Jisha V T, Christian College Kattakkada
33. Dr. Rakesh Chandran S B, SD College, Alappuzh

3. PREFACE

The Kerala University Four-Year Undergraduate Programme (FYUGP) in Physics marks a major shift in the field of higher education in Kerala, allowing students to learn according to their interests. The FYUGP in Physics is an outcome-based program that allows students the flexibility and freedom to attain their desired learning outcomes in Physics. The program is primarily multidisciplinary in nature, allowing students to explore the interaction between physics and other fields of study. This approach broadens students' perspectives and helps them realize how different areas of knowledge are interconnected. The current three-year undergraduate curriculum has been totally revamped, with a shift from a teacher-centric to a student-centric approach.

The FYUGP in Physics consists of three different types of courses: (i) discipline-specific core courses (DSC), (ii) discipline-specific elective courses (DSE), and general foundation courses. General foundation courses have three divisions: multi-disciplinary courses (MDC), value addition courses (VAC), and skill enhancement courses (SEC). The students have the flexibility to change their major or minor at the end of the second semester from the broad list of courses provided by the university. Students who choose Honours with Research can carry out a research project in their core or elective areas of study in the fourth year. Capstone courses are offered in the seventh semester. The program offers a variety of elective courses from which students can choose according to their interests. It offers students the opportunity to choose from a variety of academic and vocational paths. Students are exposed to a variety of learning contexts rather than simply memorizing and rote learning knowledge. The syllabus is aimed at stimulating critical thinking, developing problem-solving skills, and increasing creativity.

The FYUGP in Physics includes wide introductory foundation courses in Physics, paving the way for advanced-level Physics courses. Students are introduced to and thoroughly explore advanced-level physics topics in order to prepare them for research-level activities. FYUGP pedagogy is primarily activity-oriented. The practicals in the syllabus provide students with hands-on experience, allowing them to better comprehend and apply physics ideas in real-world scenarios. The syllabus adheres to globally competitive standards of knowledge and skills in physics, allowing students to be equipped with the competencies required by global industries. Internships in firms and reputable institutes will prepare students for employment and make them aware of industry-academic connections. It is believed that this program will provide students with a solid foundation in the discipline while exposing them to cutting-edge developments in the field.

The multidisciplinary and holistic nature of the program is believed to equip students with the skills and knowledge necessary for success in a rapidly changing environment.

4. GRADUATE ATTRIBUTES

Graduate attributes bridge the gap between academia and the real world, fostering lifelong learning and meaningful contributions. They denote the skills, competencies and high-level qualities that a student should acquire during their university education. Apart from gathering content knowledge, these attributes go beyond the assimilation of information to its application in various contexts throughout a graduate's life. It aims in inculcating the art of critical thinking, problem solving, professionalism, leadership readiness, teamwork, communication skills and intellectual breadth of knowledge. The University of Kerala envisages to pave the path in guiding the student's journey to shape these attributes uniquely, making them integral to personal growth and success in various spheres of life. The University strives to ensure that these graduate attributes are not just checkboxes, but they play a pivotal role in shaping the students into capable, compassionate and responsible individuals with a high degree of social responsibility.

5. PROGRAMME OUTCOMES (PO)

No.	Programme Outcomes (POs)
PO-1	**Critical thinking** ○ analyze information objectively and make a reasoned judgment ○ draw reasonable conclusions from a set of information, and discriminate between useful and less useful details to solve problems or make decisions ○ identify logical flaws in the arguments of others ○ evaluate data, facts, observable phenomena, and research findings to draw valid and relevant results that are domain-specific
PO-2	**Complex problem-solving** ○ solve different kinds of problems in familiar and no-familiar contexts and apply the learning to real-life situations ○ analyze a problem, generate and implement a solution and to assess the success of the plan

	○ understand how the solution will affect both the people involved and the surrounding environment
PO-3	**Creativity** ○ produce or develop original work, theories and techniques ○ think in multiple ways for making connections between seemingly unrelated concepts or phenomena ○ add a unique perspective or improve existing ideas or solutions ○ generate, develop and express original ideas that are useful or have values
PO-4	**Communication skills** ○ convey or share ideas or feelings effectively ○ use words in delivering the intended message with utmost clarity ○ engage the audience effectively ○ be a good listener who are able to understand, respond and empathize with the speaker ○ confidently share views and express himself/herself
PO-5	**Leadership qualities** ○ work effectively and lead respectfully with diverse teams ○ build a team working towards a common goal ○ motivate a group of people and make them achieve the best possible solution. ○ help and support others in their difficult times to tide over the adverse situations with courage
PO-6	**Learning 'how to learn' skills** ○ acquire new knowledge and skills, including 'learning how to learn skills, that are necessary for pursuing learning activities throughout life, through self-paced and self-directed learning ○ work independently, identify appropriate resources required for further learning ○ acquire organizational skills and time management to set self-defined goals and targets with timelines ○ inculcate a healthy attitude to be a lifelong learner

PO-7	**Digital and technological skills** ○ use ICT in a variety of learning and work situations, access, evaluate, and use a variety of relevant information sources ○ use appropriate software for analysis of data ○ understand the pitfalls in the digital world and keep safe from them
PO-8	**Value inculcation** ○ embrace and practice constitutional, humanistic, ethical, and moral values in life including universal human values of truth, righteous conduct, peace, love, nonviolence, scientific temper, citizenship values ○ formulate a position/argument about an ethical issue from multiple perspectives ○ identify ethical issues related to work, and follow ethical practices, including avoiding unethical behaviour such as fabrication, falsification or misrepresentation of data, or committing plagiarism, and adhering to intellectual property rights ○ adopt an objective, unbiased, and truthful actions in all aspects of work

6. PROGRAMME SPECIFIC OUTCOMES (PSO)

No.	Programme Specific Outcomes (PSO)
PSO-1	Discuss the fundamental laws, basic concepts in physics and prioritise the core knowledge in the major premises of Physics and their interconnections
PSO-2	Apply the principles of Physics and mathematical tools to analyse and solve numerical and conceptual problems in various domains, as well as formulate equations and models for describing different physical theories and phenomena.
PSO-3	Analyse concepts in space science, nanoscience and nanotechnology, atmospheric science, electronics, forensic science, energy physics, and medical physics to establish a seamless integration with industry, research and academic institutions
PSO-4	Discover a multidisciplinary perspective to recognise synergies between disciplines such as arts and sports, environmental science, history, economics, data analysis, artificial intelligence, archeophysics, geology, archaeology, history and administer

	a strong understanding of interconnected topics by integrating concepts and methodologies.
PSO-5	Administer a general awareness, skills in programming, operating systems, computer hardware and software, scientific writing, optical fibre technology, PCB making and design, photographic optics, electrical device knowledge, and devise and troubleshoot basic household appliances for fostering self employability
PSO-6	Evaluate the effectiveness and weaknesses of modern electronics, communication systems and address global concerns such as the energy crisis and natural disasters, to provide innovative solutions
PSO-7	Apply theoretical knowledge and practical skills to perform experiments in lab, solve real-world challenges and practice ethical standards in scientific research and industrial environments.

7. COURSE STRUCTURE

7.1 COURSE CATEGORY CODES

Sl No	Name of Course	Course Category Code
1	Ability Enhancement Course	AEC
2	Multi-Disciplinary Course	MDC
3	Discipline Specific Core	DSC
4	Discipline Specific Elective	DSE
5	Value Addition Course	VAC
6	Skill Enhancement Course	SEC

7.2 FOUR YEAR UG PROGRAM IN PHYSICS

Semester	Course	Credit	Academic Level	No. of courses in each semester	Minimum credit to be earned in each semester
I	**DSC1 – A1**	4	100-199	6	21
	DSC2 – B1	4			
	DSC3 – C1	4			
	AEC1 - English	3			
	AEC2 – Other Language	3			
	MDC1	3			
II	**DSC4 – A2**	4	100-199	6	21
	DSC5 – B2	4			
	DSC6 – C2	4			
	AEC3 - English	3			
	AEC4 – Other Language	3			
	MDC2	3			

III	**DSC7 – A3**	4	200-299	6	22
	DSC8 – B3	4			
	DSC9 – C3	4			
	DSE1 – A2	4			
	MDC3 – KS	3			
	VAC1	3			
IV	**DSC10 – A4**	4	200-299	6	21
	DSC11 – A5	4			
	DSE2 – A2	4			
	SEC1	3			
	VAC2	3			
	VAC3	3			
INTERNSHIP		2			2
V	**DSC12 – A6**	4	300-399	6	23
	DSC13 – A7	4			
	DSC14 – A8	4			
	DSE3 – A3	4			
	DSE4 – A4	4			
	SEC2	3			
VI	**DSC15 – A9**	4	300-399	6	23
	DSC16 – A10	4			
	DSC17 – A11	4			
	DSE5 – A5	4			
	DSE6 – A6	4			
	SEC3	3			

VII	**DSC18[#]- A12**	3	400-499	6	24
	DSC19[#]- A13	3			
	DSC20[@]- B/C	3			
	DSC21[@]- B/C	4			
	DSC22[@]- B/C	4			
	DSE7[#] – A7	4			
VIII	**DSC23[$]**	4	400-499		8+12
	DSC24[$]	4			
	INTERNSHIP PROJECT / RESEARCH PROJECT	12			

 # - Advanced Level Course

@ - 300 - 399 Level Course

$ - Online Mode

8. SYLLABUS INDEX

MAJOR DISCIPLINE: PHYSICS

(**Click Course Code / Page No to view the detailed syllabus)

Semester: 1

Course Code	Title of the Course	Type of the Course	Credit	Hours / Week	Hours Distribution / Week			Page No
					L	T	P	
UK1DSCPHY100	Foundation Course in Physics-I	DSC A	4	5	3	0	2	21
UK1DSCPHY101	Principles of Dynamics	DSC B	4	5	3	0	2	28
UK1DSCPHY102	Properties of Solids	DSC C	4	5	3	0	2	35
UK1DSCPHY103	Introduction to Mechanics and Energy resources	DSC D	4	5	3	0	2	43
UK1MDCPHY100	Elementary Data Analysis	MDC	3	3	3	0	0	49
UK1MDCPHY101	Environmental Physics	MDC	3	3	3	0	0	55
UK1MDCPHY102	Green Energy	MDC	3	3	3	0	0	61
UK1MDCPHY103	Physics in Arts and Sports	MDC	3	3	3	0	0	67
UK1MDCPHY104	Physics of Everyday Appliances	MDC	3	3	3	0	0	73

L — Lecture, T — Tutorial, P — Practical

Semester: 2

Course Code	Title of the Course	Type of the Course	Credit	Hours / Week	Hours Distribution / Week			Page No
					L	T	P	
UK2DSCPHY100	Foundation Course in Physics-II	DSC	4	5	3	0	2	79
UK2DSCPHY101	Electricity, Magnetism and Acoustics	DSC	4	5	3	0	2	85
UK2DSCPHY102	Optics and Thermodynamics	DSC	4	5	3	0	2	92
UK2DSCPHY103	Modern Physics	DSC	4	5	3	0	2	99
UK2MDCPHY100	Archaeo Physics	MDC	3	3	3	0	0	105
UK2MDCPHY101	Basics of Artificial Intelligence	MDC	3	3	3	0	0	111
UK2MDCPHY102	Beyond the Sky	MDC	3	3	3	0	0	117
UK2MDCPHY103	Foundations in Forensic Science	MDC	3	3	3	0	0	122
UK2MDCPHY104	Medical Physics	MDC	3	3	3	0	0	128

Semester: 3

Course Code	Title of the Course	Type of the Course	Credit	Hours / Week	Hours Distribution / Week			Page No
					L	T	P	
UK3DSCPHY200	Basic Electronics	DSC	4	5	3	0	2	133
UK3DSCPHY201	Digital Electronics and Datascience	DSC	4	5	3	0	2	139
UK3DSCPHY202	Solid State Physics and Spectroscopy	DSC	4	5	3	0	2	146
UK3DSCPHY203	Heat, Magnetism and Geophysics	DSC	4	5	3	0	2	152

UK3DSCPHY204	Light, Electricity and Emerging energy sources	DSC	4	5	3	0	2	158
UK3DSEPHY200	Fundamentals of Earth - Atmosphere System	DSE	4	4	4	0	0	166
UK3DSEPHY201	Circuit Elements and Network Theorems	DSE	4	4	4	0	0	172
UK3DSEPHY202	Basics of Nanoscience and Nanotechnology	DSE	4	4	4	0	0	177
UK3DSEPHY203	Fundamentals of Astrophysics	DSE	4	4	4	0	0	183
UK3DSEPHY204	Introduction to Medical Physics	DSE	4	4	4	0	0	189
UK3DSEPHY205	Mathematical tools for Physics	DSE	4	4	4	0	0	195
UK3DSEPHY206	Computer Hardware and Operating System	DSE	4	4	4	0	0	201
UK3VACPHY200	Energy crisis, Sustainability and Management	VAC	3	3	3	0	0	206
UK3VACPHY201	Introduction to laboratory safety measurements	VAC	3	3	3	0	0	215
UK3VACPHY202	The history of physics and its influence on society	VAC	3	3	3	0	0	221

Semester: 4

Course Code	Title of the Course	Type of the Course	Credit	Hours / Week	Hours Distribution / Week			Page No
					L	T	P	
UK4DSCPHY200	Classical Dynamics	DSC	4	5	3	0	2	230
UK4DSCPHY201	Electromagnetics and Transient Currents	DSC	4	5	3	0	2	238
UK4DSEPHY200	Atmospheric Thermodynamics (*AP)	DSE	4	5	3	0	2	246
UK4DSEPHY201	Basic digital principles and applications (*EL)	DSE	4	5	3	0	2	254
UK4DSEPHY202	Synthesis of Nanomaterials (*NS)	DSE	4	5	3	0	2	259
UK4DSEPHY203	Solar Terrestrial Physics (*AP)	DSE	4	5	3	0	2	266
UK4DSEPHY204	Physical Aspects of Diagnostics	DSE	4	5	3	0	2	273
UK4DSEPHY205	C++ Programming for Physics	DSE	4	5	3	0	2	282
UK4DSEPHY206	Fibre Optic communication	DSE	4	5	3	0	2	288
UK4SECPHY200	Basic Instrumentation Skills	SEC	3	4	2	0	2	295
UK4SECPHY201	Wiring and Electrical Devices	SEC	3	4	2	0	2	301
UK4VACPHY200	Introductory course on physics in financial market	VAC	3	3	3	0	0	308
UK4VACPHY201	Research and Publication Ethics	VAC	3	3	3	0	0	314
UK4VACPHY202	Disaster management	VAC	3	3	3	0	0	320
UK4INTPHY200	Capstone Internship	INT	2	2	-	-	-	-

Semester: 5

Course Code	Title of the Course	Type of the Course	Credit	Hours / Week	Hours Distribution / Week			Page No
					L	T	P	
UK5DSCPHY300	Optics	DSC	4	5	3	0	2	326
UK5DSCPHY301	Quantum Mechanics - I	DSC	4	4	4	0	0	333
UK5DSCPHY302	Thermodynamics & Statistical Mechanics	DSC	4	5	3	0	2	339
UK5DSEPHY300	Dynamics of the Atmosphere	DSE	4	4	4	0	0	347
UK5DSEPHY301	Transistor Amplifier circuits and Oscillators	DSE	4	4	4	0	0	354
UK5DSEPHY302	Characterization of Nano Materials	DSE	4	4	4	0	0	359
UK5DSEPHY303	Solar and Plasma Physics	DSE	4	4	4	0	0	364
UK5DSEPHY304	Physical Aspects of Therapeutics	DSE	4	4	4	0	0	369
UK5DSEPHY305	Forensic Physics	DSE	4	4	4	0	0	375
UK5DSEPHY306	Research Methodology	DSE	4	4	4	0	0	381
UK5SECPHY300	Optics in Digital Photography	SEC	3	3	3	0	0	385
UK5SECPHY301	Programming in Java	SEC	3	3	3	0	0	393
UK5SECPHY302	Programming in Python	SEC	3	3	3	0	0	401

Semester: 6

Course Code	Title of the Course	Type of the Course	Credit	Hours / Week	Hours Distribution / Week			Page No
					L	T	P	
UK6DSCPHY300	Atomic & Molecular Physics	DSC	4	4	4	0	0	409
UK6DSCPHY301	Nuclear & Particle Physics	DSC	4	4	4	0	0	416
UK6DSCPHY302	Solid State Physics	DSC	4	4	4	0	0	422
UK6DSEPHY300	Observing of Weather and Climate (*AP)	DSE	4	5	3	0	2	428
UK6DSEPHY301	Operational Amplifiers and Applications (*EL)	DSE	4	5	3	0	2	436
UK6DSEPHY302	Nanotechnology For Energy Conversion and Storage Devices (*NS)	DSE	4	5	3	0	2	442
UK6DSEPHY303	Ionosphere and Magnetosphere (*AP)	DSE	4	5	3	0	2	449
UK6DSEPHY304	Practical Medical Physics	DSE	4	5	3	0	2	456
UK6DSEPHY305	Applied Optics	DSE	4	5	3	0	2	463
UK6DSEPHY306	Computational Physics	DSE	4	5	3	0	2	470
UK6DSEPHY307	Numerical Methods in Physics	DSE	4	5	3	0	2	478
UK6SECPHY300	Fibre Optic Technology	SEC	3	3	3	0	0	484

UK6SECPHY301	PCB Making and Designing	SEC	3	3	3	0	0	490
UK6SECPHY302	Scientific writing	SEC	3	3	3	0	0	496
UK6SECPHY303	Computer Hardware and Assembling	SEC	3	3	3	0	0	502

Semester: 7

Course Code	Title of the Course	Type of the Course	Credit	Hours / Week	Hours Distribution / Week			Page No
					L	T	P	
UK7DSCPHY400	Advanced Mathematical Physics	DSC	4	4	4	0	0	508
UK7DSCPHY401	Quantum Mechanics-II	DSC	4	4	4	0	0	514
UK7DSEPHY400	Weather Analysis and Forecasting	DSE	4	4	4	0	0	519
UK7DSEPHY401	Environmental Sustainability of Nanomaterials	DSE	4	4	4	0	0	526
UK7DSEPHY402	Frontiers of Space Science, Technology and Programming	DSE	4	4	4	0	0	533

Semester: 8

Course Code	Title of the Course	Type of the Course	Credit	Hours / Week	Hours Distribution / Week		
					L	T	P
UK8CIPPHY400	Capstone Internship	CIP	12	-	-	-	-
UK8RPHPHY400	Research Project	RPH	12	-	-	-	-

ADDITIONAL ELECTIVE COURSES- RECOMMENDED EXCLUSIVELY FOR INTER DISCIPLINARY MAJOR PATHWAY

Course Code	Title of the Course	Type of the Course	Credit	Hours / Week	Hours Distribution / Week			Page No
					L	T	P	
Semester 3								
UK3DSEPHY207	Electrodynamics	DSE	4	5	3	0	2	539
Semester 5								
UK5DSEPHY307	Modern Optics	DSE	4	5	3	0	2	547
Semester 6								
UK6DSEPHY308	Atomic and Molecular Spectroscopy	DSE	4	4	4	0	0	554
Semester 7								
UK7DSEPHY403	Mathematical Physics	DSE	4	4	4	0	0	561

9. DSC COURSES FOR PHYSICS MAJOR IN BRIEF

SEM	Course code	Course Name
1	UK1DSCPHY100	Foundation Course in Physics-I
2	UK2DSCPHY100	Foundation Course in Physics-II
Compulsory courses for Physics major		
3	UK3DSCPHY200	Basic Electronics
4	UK4DSCPHY200	Classical Dynamics
4	UK4DSCPHY201	Electromagnetics and Transient Currents
5	UK5DSCPHY300	Optics
5	UK5DSCPHY301	Quantum Mechanics - I
5	UK5DSCPHY302	Thermodynamics & Statistical Mechanics
6	UK6DSCPHY300	Atomic & Molecular Physics
6	UK6DSCPHY301	Nuclear & Particle Physics
6	UK6DSCPHY302	Solid State Physics

10. SPECIALIZATION STREAMS

10.1: STREAM CODE

Physics offers five different specialisation streams in elective (DSE) courses. Out of the trial required DSE courses a student is studying, if the students take any four courses from a particular stream the student is eligible to get specialisation title in their degree.

Sl No	Stream Code	Stream
1	AP	Atmospheric science
2	EL	Electronics
3	NS	Nanoscience and Nanotechnology
4	SP	Space Physics
5	MP	Medical Physics

10.2: COURSE CODE FOR SPECIALIZATION STREAM

(Minimum of any four from each stream is compulsory for getting specialization in that particular stream)

Sem	AP	EL	NS	SP	MP
3	UK3DSEPHY200	UK3DSEPHY201	UK3DSEPHY202	UK3DSEPHY203	UK3DSEPHY204
4	UK4DSEPHY200	UK4DSEPHY201	UK4DSEPHY202	UK4DSEPHY203	UK4DSEPHY204
5	UK5DSEPHY300	UK5DSEPHY301	UK5DSEPHY302	UK5DSEPHY303	UK5DSEPHY304
6	UK6DSEPHY300	UK5DSEPHY301	UK6DSEPHY302	UK6DSEPHY303	UK6DSEPHY304
7	UK7DSEPHY400		UK7DSEPHY401	UK7DSEPHY402	

11. PRACTICALS

A minimum of 5 experiments to be performed from Part A and a minimum of 1 experiment to be performed from part B during a semester.

12. TEACHER CONTENT

20% of both theoretical (fifth module in each course (*marked)) and practical components (Part B (*marked)) can be changed by the faculty with the prior approval of BoS (pass) Physics.

13. FIELD TRIP / STUDY TOUR

A field trip or study tour should be conducted during the third year, and the report can be submitted at the end of the sixth semester. Students are directed to visit a research institute / science museum / observatory / industrial institute / factory, and a scientifically prepared handwritten study tour report must be submitted by each student.

14. DETAILED SYLLABUS

University of Kerala

Discipline	**PHYSICS**				
Course Code	**UK1DSCPHY100**				
Course Title	**FOUNDATION COURSE IN PHYSICS-I**				
Type of Course	**DSC**				
Semester	**I**				
Academic Level	**100 - 199**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 Hrs	-	2 Hrs	5 Hrs
Pre-requisites	-				
Course Summary	This course discusses basic foundation concepts in Physics. Simple mathematical tools required for understanding Physical concepts are discussed in the first module. Motion of objects is explained on the basis of Newton's laws followed by the discussion on work and energy. Study on rotational dynamics reveals the concept of angular momentum and its significance in rigid bodies. The discussion on oscillations will help to understand simple harmonic motion and its applications in pendulum.				

BOOKS FOR STUDY:

1. Introduction to Electrodynamics, David J Griffiths, Prentice Hall
2. Sear and Zemansky's University Physics With Modern Physics, Hugh D Young, Roger A Freedman, Addison -Wesley, 13TH EDITION, 2012.
3. Introduction to Mechanics, Daniel Kleppner and Robert Kolenkow Second Edition, Mc Graw Hill Education, 2017.
4. Mechanics, J C Upadhyaya, Ramprasad Publications
5. Principles of Physics 10th Edition, Robert Resnick, Jearl Walker, David Halliday, Wiley, 2014.

BOOKS FOR REFERENCE:

1. Mechanics: H. S. Hans and S. P. Puri, TMH, 2ndEdn.
2. Properties of matter: Brijlal and Subramaniam, S. Chand & Co.,2004
3. Principles of Physics: P.V. Naik, PHI,

DETAILED SYLLABUS: THEORY

Module	Unit	Content	Hrs	CO No
I		**LANGUAGE OF PHYSICS (Book 1: Chapter 1)**	**9**	
	1	Vector algebra - vector operations, component form, triple products,	3	1
	2	Gradient, the operator ∇, the divergence, the curl, product rules	4	1
	3	Integral calculus: line, surface and volume integrals	1	1
	4	Gauss's divergence theorem and Stokes's theorem (statements only)	1	1
II		**LAWS OF MOTION (Book 2: Chapter 4 & 8)**	**9**	
	5	Newton's first law, law of inertia - Inertial frame of reference	2	2
	6	Newton's second law- Mass and Force	1	2
	7	Mass and weight- Variation of g with location, measuring mass and weight	2	3,5
	8	Newton's third law	1	2
	9	Momentum and impulse - Newton's second law in terms of Momentum, The impulse-momentum theorem	2	2
III		**DYNAMICS OF MOTION- WORK AND ENERGY (Book 2: Chapter 6 & 7)**	**9**	
	10	Work, Kinetic energy and work - energy theorem	1	2,5
	11	Work and energy with varying forces- Straight line motion, Motion along a curve, Power	2	2,5
	12	Gravitational Potential energy, elastic Potential energy	3	2

	13	Conservative and non-conservative forces, Law of Conservation of energy	2	3,5
	14	Force and potential energy	1	2,5
IV	**DYNAMICS OF ROTATION AND ANGULAR MOMENTUM (Book 2, Book 3 and Book 4)**		**9**	
	15	Torque, Angular acceleration, Rigid body rotation about a moving axis	4	2
	16	Combined translation and rotation-energy relations, rolling without slipping. Rolling friction, work and power in rotational motion (Book2: Chapter 10)	4	4,5
	17	Angular momentum of a particle, fixed axis rotation- Moment of Inertia (ring, Disc, Stick), The Parallel axis theorem, dynamics of fixed axis rotation	3	4,5
V*	**UNDERSTANDING OSCILLATIONS (Book 6, Book 2)**		**9**	
	18	Simple Harmonic motion, Energy in Simple Harmonic motion (Book6, Chapter 15)	3	6
	19	mass on a spring - oscillation of two particles connected by a spring (Book 2, Chapter 9)	2	6
	20	compound pendulum - interchange ability of suspension and oscillation points-collinear points-conditions for maximum and minimum periods (Book 2, Chapter 9)	4	6

DETAILED SYLLABUS: PRACTICALS

Part A – At least 5 Experiments to be performed		**CO No**
Sl No	**Name of Experiment**	
1	Compound Bar Pendulum – Symmetric	6
2	Compound Bar Pendulum – Asymmetric.	6
3	Determination of moment of inertia of fly wheel	4, 6
4	Helical spring- Spring constant	2, 6

5	Show that the period of oscillation of a simple pendulum is independent of the mass of the bob used.	6
6	Establish the relationship between length and period of a simple pendulum.	6
Part B* – At least One Experiment to be performed		
7	Inclined plane - determine the downward force, along an inclined plane	1, 2
8	Concurrent forces - determination of unknown mass	1, 2
9	Concurrent forces - parallelogram law verification	1, 2

COURSE OUTCOMES

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Discuss the basic mathematical tools used to manipulate vectors and associated problems	U, Ap	1, 2, 4
CO-2	Recall Newton's laws of motion and describe basic concepts related to objects in motion like momentum, inertia, work, energy and simple harmonic motion.	R, U	1, 2
CO-3	Use the basic ideas of Newtonian mechanics to evaluate dynamics of objects in detail.	R, U	1, 2
CO-4	Describe the concept of moment of inertia and use it to objects having different shapes	R, U, Ap	1, 2, 7
CO-5	Solve numerical problems related to motion of objects	U, Ap	1, 2
CO-6	Relate the concept of simple harmonic motion with periodic movement of objects	U, Ap	1, 2, 7

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: FOUNDATION COURSE IN PHYSICS-I

Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PSO / PO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Discuss the basic mathematical tools used to manipulate vectors and associated problems	PSO 1, 2, 4/ PO 1, 2	U, Ap	F, C	L	P
CO-2	Recall Newton's laws of motion and describe basic concepts related to objects in motion like momentum, inertia, work, energy and simple harmonic motion.	PSO 1, 2/ PO 1, 2	R, U	F, C	L	-
CO-3	Use the basic ideas of Newtonian mechanics to evaluate dynamics of objects in detail.	PSO 1, 2/ PO 1, 2	R, U	F, C	L	-
CO-4	Describe the concept of moment of inertia and use it to objects having different shapes	PSO 1, 2/ PO 1, 2	R, U, Ap	F, C, P	L	P
CO-5	Solve numerical problems related to motion of objects	PSO 1, 2, 7/ PO 1, 2	U, Ap	F, C	L	-

CO-6	Relate the concept of simple harmonic motion with periodic movement of objects	PSO 1, 2, 7/ PO 1, 2, 3, 6	U, Ap	F, C, P	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO-1	3	2	-	1	-	-	-	1	3	-	-	-	-	-	-
CO-2	3	1	-	-	-	-	-	2	2	-	-	-	-	-	-
CO-3	3	2	-	-	-	-	-	2	3	-	-	-	-	-	-
CO-4	2	1	-	-	-	-	-	1	2	-	-	-	-	-	-
CO-5	2	3	-	-	-	-	1	2	3	-	-	-	-	-	-
CO-6	2	2	-	-	-	-	2	3	2	1	-	-	2	-	-

Correlation Levels:

Level	-	1	2	3
Correlation	Nil	Slightly / Low	Moderate / Medium	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

CO No	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO-1	✓	-	-	✓
CO-2	✓	-	-	✓
CO-3	✓	-	-	✓
CO-4	✓	✓	-	✓
CO-5	✓	-	-	✓
CO-6	✓	✓	-	-

University of Kerala

Discipline	**PHYSICS**				
Course Code	**UK1MDCPHY104**				
Course Title	**PHYSICS OF EVERYDAY APPLIANCES**				
Type of Course	**MDC**				
Semester	**I**				
Academic Level	**100 - 199**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	3 Hrs	-	-	3 Hrs
Pre-requisites					
Course Summary	"This course provides a basic exploration of the physical principles underlying everyday appliances and technologies. From the basics of electronics and electricity to modern communication technology, students will gain a comprehensive understanding of how various devices work, their impact on energy consumption and efficiency."				

BOOKS FOR STUDY:

1. Louis A Bloomfield – "How things works – The physics of everyday life" - 5-th Edition - Willy Publications (2013)
2. Eric Kleinert - "Trouble shooting and repairing major appliances" Third Edition - McGraw Hills companies (2013)
3. Disseminating Star Labelling in Household Appliance (DISHA) Operational Manual, Bureau of Energy Efficiency

BOOKS FOR REFERENCE:

1. Edison's Electric Light: The Art of Invention (Johns Hopkins Introductory Studies in the History of Technology)
2. LED Lighting: A Primer to Lighting the Future, Sal Cangeloso
3. "The Physics of Everyday Things: The Extraordinary Science Behind an Ordinary Day" by James Kakalios
4. "Optics" by Eugene Hecht

WEB REFERENCES

1. https://www.energy.gov/articles/history-light-bulb
2. Energy_efficient_Ceiling_fans_using_BLDC_motors-A_practical_implementation - Dr Mahesh Rao (https://www.researchgate.net/profile/Mahesh-Rao-8/publication/325922681_Energy_efficient_Ceiling_fans_using_BLDC_motors-A_practical_implementation/links/5b2c7dcfa6fdcc8506bc8680/Energy-efficient-Ceiling-fans-using-BLDC-motors-A-practical-implementation.pdf)
3. Induction stoves: An option for clean and efficient cooking in Indonesia – Tiandho, Yuant etal 2020 (doi:10.1088/1757-899X/1034/1/012068)

DETAILED SYLLABUS: THEORY

Module	Unit	Content	Hrs	CO No
I		**Lighting Devices (Ref Web Link -1, Book-1 section 13.2-13.3, Book 3)**	**9**	
	1	History of light bulbs	1	1
	2	Discharge lamps, fluorescent lamps - mercury, metal-halide, and sodium lamps	3	1
	3	Light-emitting diodes- working of led	2	1
	4	Lasers - types of lasers	1	1
	5	Need for saving energy - bee standards & labelling	2	1
II		**Mirrors, Lenses, and Camera (Book-1, section 14.1)**	**7**	
	6	Introduction to mirrors and lenses, real images - focusing and lens diameter	2	2

	7	Focal lengths and f-numbers - improving the quality of a camera lens - the viewfinder and virtual images	2	2
	8	Image sensors - limit of resolution	2	2
	9	Eyes and eye glasses	1	2
III	**Heat Transfer and Cooling Systems (Book-1, section 7.1, 8.2, 8.1)**		**11**	
	10	Woodstoves -thermal conductivity, conduction, convection, radiation, heat capacity	1	3
	11	Microwave ovens – speed, frequency, and wavelength in electromagnetic waves - polar and nonpolar molecules - working of ovens	2	3
	12	Induction stoves - basic principles	2	3
	13	Automobiles - using thermal energy: heat engines – the internal combustion engine, efficiency	3	3
	14	Air conditioners - pumping heat against its natural flow - how an air conditioner cools the indoor air - how an air conditioner warms the outdoor air	3	3
IV	**Other Domestic Appliances (Book-1, section 9.1, 9.2, Web Link-2)**		**9**	
	15	Clocks- working - time and space, natural resonance, simple harmonic motion, frequency, period, amplitude	3	1
	16	Musical Instruments: sound; music; vibrations in strings, air, surfaces, fundamental and higher-order modes; harmonic and nonharmonic overtones; sympathetic vibration; standing and traveling waves; transverse and longitudinal waves.	5	1
	17	BLDC Motors - features, applications (Fan, Pump)	1	1
V*	**Hands on Training (Book-2, Chapter 6 & 7)**		**9**	
	18	(Any five experiments to be done) 1. Soldering technique 2. Electric tester	9	4

		3. Checking the continuity of electrical components in simple circuits using multimeter 4. Assembling/replacing of fuse wire in household devices 5. Familiarization of resistor, capacitor, diode, transformer 6. One lamp controlled by one switch - soldering 7. One lamp controlled by two switch - soldering 8. Led bulb/tube light making, and troubleshooting 9. Finding the focal length of lens 10. Making of simple electrical extension boards 11. Electric earthing system 12. Energy auditing of devices		

COURSE OUTCOMES

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Summarize the basics of lighting technology, domestic appliances including proficiency in energy efficiency standards and labelling programs established by the Bureau of Energy Efficiency (BEE)	R, U	PSO-1, 4,6
CO-2	Understand the working of optical systems and imaging devices such as camera.	R, U	PSO-1, 2,3,4
CO-3	Discuss basic knowledge of heat transfers and technology in common appliances.	R, U	PSO-1, 4
CO-4	Administer practical skills through hands-on experiments, including soldering, circuit construction etc.	R, U, Ap	PSO-3,6,7

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: PHYSICS OF EVERYDAY APPLIANCES

Credits: 3:0:0 (Lecture: Tutorial: Practical)

CO No.	CO	PO / PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Demonstrate a comprehensive understanding of lighting technology.	PO 4,7/ PSO-1, 4,6	U	F, C	L	P
CO-2	Understand the working of optical systems and imaging devices such as camera.	PO 4,7/ PSO-1, ,2,3,4	R, U	F, C, P	L/T	P
CO-3	Develop basic knowledge of heat transfers and technology in common appliances.	PO 4,7/ PSO-1,4	R, U	F, C, P	L	-
CO-4	Develop fundamental Knowledge of electronics and electricity and also to develop practical skills through hands-on experiments, including soldering, circuit construction etc.	PO 3,4,7/ PSO-3,67	R, U, A	F,C,P	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO-1	2	-	-	3	-	3	-	-	-	-	1	-	-	1	-
CO-2	2	3	3	3	-	-	-	-	-	-	1	-	-	1	-
CO-3	2	-	-	3	-	-	-	-	-	-	1	-	-	1	-
CO-4	-	-	3	-	-	3	3	-	-	1	1	-	-	3	-

Correlation Levels:

Level	-	1	2	3
Correlation	Nil	Slightly / Low	Moderate / Medium	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics:

CO No	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO-1	✓	-	-	✓
CO-2	✓	-	-	✓
CO-3	✓	✓	-	✓
CO-4	✓	✓	-	-

University of Kerala

Discipline	**PHYSICS**				
Course Code	**UK2DSCPHY100**				
Course Title	**FOUNDATION COURSE IN PHYSICS-II**				
Type of Course	**DSC**				
Semester	**II**				
Academic Level	**100 - 199**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 Hrs	-	2 Hrs	5 Hrs
Pre-requisites	-				
Course Summary	This course discusses the basic concepts required to learn advanced physics courses. The concept of error and precision emphasises the importance of numbers when expressing the magnitude of a quantity. Discussion on waves basic features of waves and its expression. Basic concepts of fluids helps us to understand application level problems like venturi meter and aeroplane wings. The discussion on elasticity gives an idea about different elastic moduli.				

BOOKS FOR STUDY:

1. Principles Of Physics 10th Edition, Robert Resnick Jearl Walker, David Halliday, Wiley, 2014.
2. Sear and Zemansky's University Physics With Modern Physics, Hugh D Young, Roger A Freedman, Addison -Wesley, 13TH EDITION, 2012.
3. College Physics 2e, PAUL PETER URONE, ROGER HINRICHS, Openstax, 2022
4. Elements of Properties of Matter: D.S. Mathur, S. Chand Publications,2014

BOOKS FOR REFERENCE:

1. Mechanics: J. C. Upadhyaya and Ram Prasad, S. Chand Publications, 2017
2. Mechanics: H. S. Hans and S. P. Puri, TMH, 2ndEdn.
3. Properties of matter: Brijlal and Subramaniam, S. Chand & Co.,2004
4. Principles of Physics: P.V. Naik, PHI, 2010
5. Principles Of Physics 10th Edition, Robert Resnick Jearl Walker, David Halliday, Wiley, 2014.

WEB REFERENCE

1. https://www.owlnet.rice.edu/~labgroup/pdf/Error_analysis.htm
2. https://faraday.physics.utoronto.ca/PVB/Harrison/ErrorAnalysis/

DETAILED SYLLABUS: THEORY

Module	Unit	Content	Hrs	CO No
I		**PRECISION IN PRACTICE (Web 1, Web 2)**	**9**	
	1	Significant figures (Web 1)	1	1
	2	Absolute and relative error (Web 1)	1	1
	3	Systematic error (Web 1)	1	1
	4	Random error, estimating random errors (Web 1)	1	1
	5	Propagation of errors (Web 1)	2	1
	6	Precision and accuracy (Web 2)	2	1
	7	Error bars and graphical representation (Web 2)	1	1
II		**PHYSICAL WORLD OF WAVES (Book1: Chapter 16)**	**9**	
	8	Types of waves – Mechanical, Electromagnetic and matter waves, Transverse and longitudinal waves	1	2
	9	Amplitude, phase, wavelength, wave number, period , frequency, angular frequency, phase constant, Speed of a travelling wave	2	2
	10	Wave Speed on a stretched string, energy and power of a wave travelling along a string	2	2

	11	Wave equation	1	2
	12	The principle of Superposition of waves	1	2
	13	Standing waves and resonance(qualitative idea)	2	2
III	**FLUID STATICS (Book 3: Chapter 11)**		**6**	
	14	Cohesion and adhesion of liquids, surface tension - pressure inside a bubble, capillary action	4	3
	15	Pressure in the body: Blood pressure, pressure in eye, Pressure Associated with the Lungs, Other Pressures in the Body: Spinal Column and Skull- Bladder Pressure- Pressures in the Skeletal System	2	3
IV	**FLUID DYNAMICS (Book 2: Chapter 12 and Book 3: Chapter 12)**		**12**	
	16	Fluid flow-streamline and turbulent flow, continuity equation (Book 2: Chapter 12)	2	3
	17	Bernoulli's equation -derivation, venturi meter, lift on an aeroplane wing (Book 2: Chapter 12)	4	3
	18	Viscosity and Laminar Flow; Poiseuille's Law, Motion of an Object in a Viscous Fluid (Book 3: Chapter 12)	4	3
	19	Molecular Transport Phenomena: Diffusion, rate and direction of diffusion, Osmosis and Dialysis - Diffusion across Membranes (Book 3: Chapter 12)	2	3
V*	**BEAUTY OF DEFORMATION AND RESTORATION (Book1, Book4)**		**9**	
	20	Condition for equilibrium, Centre of Gravity (Book1: Chapter 11)	1	4
	21	Stress, Strain, and Elastic Moduli- Hook's law, Tensile stress and strain, Bulk Stress and Strain, Shear Stress and Strain (Book1: Chapter 11)	2	4
	22	bending of beams, bending moment, cantilever, Beams supported at its ends and loaded in the middle (Book 4: Chapter 12)	3	4

	23	Twisting couple on a cylindrical rod or wire, work done in twisting a wire, torsion pendulum (Book 4: Chapter 12)	3	4

DETAILED SYLLABUS: PRACTICALS

Part A – At least 5 Experiments to be performed		**CO No**
Sl No	**Name of Experiment**	
1	Uniform bending—Y- optic lever method	4
2	Non-uniform bending-Y-Optic lever & telescope	4
3	Rigidity modulus –Static torsion	4
4	Torsion pendulum I- By Torsional oscillations.	4
5	Torsion pendulum I- By Equal masses.	4
6	Viscosity-Continuous flow method using constant pressure head.	3
7	Viscosity-Variable pressure head arrangement	3
8	Surface tension-Capillary rise.	3
Part B* – At least One Experiment to be performed		
9	Evaluation of errors in simple experiments.	1
10	Experiment to demonstrate random error, by taking dimensions of a small rectangular object using Vernier calliper and evaluate the volume of the object	1
11	Comparison of least counts of measuring instruments.	1
12	Uniform Bending- determination of Y using pin and Microscope	4
13	Determination of the viscosity of fluid using Stoke's method.	3

COURSE OUTCOMES

No.	**Upon completion of the course the graduate will be able to**	**Cognitive Level**	**PSO addressed**
CO-1	Discuss the basics of error analysis and use it in expressing physical quantities.	U, Ap	1, 2, 7

CO-2	Identify the basic concepts of waves and its mathematical expression to understand periodic wave motion	R, U	1, 2
CO-3	Observe physical concepts of fluids in rest and motion, to relate them with real world examples	R, U	1, 2, 7
CO-4	Cite Hook's law and apply it to calculate the elastic moduli of beams and rods.	U, Ap	1, 2, 7

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: FOUNDATION COURSE IN PHYSICS-II

Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	**CO**	**PO/ PSO**	**Cognitive Level**	**Knowledge Category**	**Lecture (L)/ Tutorial (T)**	**Practical (P)**
CO-1	Discuss the basics of error analysis and use it in expressing physical quantities.	PSO 1, 2, 7/ PO 1, 2	U, Ap	F, C, P	L	P
CO-2	Identify the basic concepts of waves and its mathematical expression to understand periodic wave motion	PSO 1, 2, 7/ PO 1, 2	R, U	F, C	L	
CO-3	Observe physical concepts of fluids in rest and motion, to relate them with real world examples	PSO 1, 2, 7/ PO 1, 2	R, U	F, C, P	L	P
CO-4	Cite Hook's law and apply it to calculate the elastic moduli of beams and rods.	PSO 1, 2, 7/ PO 1, 2	U, Ap	F, C, P	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO-1	2	2	-	-	-	-	2	1	1	-	-	-	-	-	-
CO-2	3	1	-	-	-	-	-	2	2	-	-	-	-	-	-
CO-3	3	2	-	-	-	-	3	2	2	-	-	-	-	-	-
CO-4	3	2	-	-	-	-	3	3	3	-	-	-	-	-	-

Correlation Levels:

Level	-	1	2	3
Correlation	Nil	Slightly / Low	Moderate / Medium	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

CO No	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO-1	✓	-	-	✓
CO-2	✓	-	-	✓
CO-3	✓	-	-	✓
CO-4	-	✓	-	-

University of Kerala

Discipline	**PHYSICS**				
Course Code	**UK3DSCPHY200**				
Course Title	**BASIC ELECTRONICS**				
Type of Course	**DSC**				
Semester	**III**				
Academic Level	**200 - 299**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 Hrs	-	2 Hrs	5 Hrs
Pre-requisites					
Course Summary	This course aims to familiarise the electronic components, their characteristics and applications. It also helps to understand the linear IC 741 and its mathematical operations.				

BOOKS FOR STUDY:

1. Principles of Electronics: V. K. Mehta and Rohit Mehta, S. Chand Ltd.,2020 Edition
2. Basic Electronics-Solid State: B. L. Theraja, S. Chand Ltd. 2005
3. Basic Electronics: Devices, circuits and IT fundamentals: Santiram Kal, PHI, 2010

BOOKS FOR REFERENCE:

1. Electronic Devices and Circuit theory: Robert Boylestad & Louis Nashelski, PHI,5th Edn.
2. Electronic Fundamentals & Applications: John D Ryder, PHI, 4thEdn.
3. Introduction to semiconductor materials and Devices, M.S Tyagi, Wiley India (2005)
4. Electronic circuits; Analysis and Design, Donald Neamen, Mc Graw Hill Education India (Third Edition)

5. Operational Amplifiers and Linear integrated circuits, R. A Gayakwad, Prentice Hall India (Fourth Edition 2015)
6. Digital Principles and Applications, Donald P Leach and Albert Paul Malvino, The Mc Graw Hill Company, Sixth Edition

DETAILED SYLLABUS: THEORY

Module	Unit	Content	Hrs	CO No
I		**Diodes and Transistors (Book 2: Chapter 13, 15, 18 & 19)**	**9**	
	1	P-N Junction Diode - Characteristics, Zener diode, Zener diode as Voltage regulator	2	1
	2	Rectification: Halfwave, Full wave-Centre tap, Bridge rectifiers (Derivations not required), RC Filter circuit, Dual power supply	3	1, 6
	3	BJT-Theory of BJT operation and Configurations	2	1
	4	CB and CE characteristics and Gain parameters	2	2
II		**Transistor Amplifiers (Book 1: Chapter 8, 9, 10 & 11)**	**9**	
	5	Need for biasing and stabilization, stability factor-Thermal Runaway (Basic ideas only)	1	2, 6
	6	Selection of Operating point- ac and dc Load lines	2	2
	7	Collector feedback; base resistor and potential divider methods (CE configuration only)	2	2
	8	BJT amplifiers - analysis of CE amplifier (frequency response, band width, impedance and gain)	2	2, 6
	9	Multi stage Amplifiers- RC and Transformer coupled amplifiers	2	2
III		**Feedback Circuits (Book 2: Chapter 25 & 28)**	**9**	
	10	Feedback principles – Negative feedback - advantages of negative feedback	2	3
	11	Forms of negative feedback (Series and shunt)	1	3
	12	Positive feedback - Barkhausen criterion for oscillations	2	3
	13	Principle of Sinusoidal oscillation	1	3
	14	Hartley Oscillator, Colpitt's Oscillator and RC phase shift oscillator (derivations not required)	3	3,6

IV	**Operational Amplifiers (Book 1: Chapter 25)**		**9**	
	15	Differential amplifier- Common mode and Differential signals	2	4
	16	Voltage gain in Differential amplifiers- CMRR	1	4
	17	Concept of Virtual Ground, Ideal Op Amp and its features- Familiarising IC 741 Op Amp	1	4
	18	Inverting and Non inverting Amplifiers	2	4
	19	Op Amp Applications: Voltage follower, Adder, Subtractor	2	4,6
	20	Op Amp Applications: Integrator-Differentiator	1	4, 6
V*	**Logic Gates and Boolean Algebra (Book 2: Chapter 33 & 34)**		**9**	
	21	Positive and Negative logic- Basic Logic gates (OR, AND and NOT)	2	5, 6
	22	De Morgan's theorem, Bubbled gates, Universal gates and XOR gates	3	5
	23	Laws of Boolean Algebra-Equivalent circuits (Solving simple circuits only)	2	5
	24	Adders and Subtractors	2	5

DETAILED SYLLABUS: PRACTICALS

Part A – At least 5 Experiments to be performed		**CO No**
Sl No	**Name of Experiment**	
1	**PN junction Diode (Ge & Si) characteristics**-To draw the characteristic curves of a PN junction diode and to determine its ac and dc forward resistances.	6
2	**Full wave (centre tapped) rectifier**-To construct a full wave rectifier using junction diode and to calculate the ripple factor with and without shunt filter	6
3	**Bridge rectifier**-To construct a bridge rectifier using junction diodes and to calculate the ripple factor with and without shunt filter	6
4	**Zener diode as a voltage regulator**-To construct a voltage regulator using Zener diode and to study its line regulation and load regulation.	6

5	**Transistor CE characteristics**-To draw the characteristic curves of a transistor in the CE configuration and determine the current gain, input impedance and output impedance	6
6	**OP amp. IC741- Inverting amplifier**-To construct an inverting amplifier using IC741 and determine its voltage gain	6
7	**OP amp. IC741- Non-inverting amplifier -** To construct a non-inverting amplifier using IC741 and determine its voltage gain	6
8	**Logic Gates** (AND, OR and NOT) using Diodes and Transistor	6
Part B* – At least One Experiment to be performed		
9	**Dual power supply**-To construct a dual power supply using bridge rectifier and measure the output voltages for different pair of identical load resistors	6
10	**Single stage CE amplifier**- To construct a single stage CE transistor amplifier and study its frequency response (designing not required).	6
11	**RC Phase shift oscillator (**using transistor**)**	6

COURSE OUTCOMES

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Familiarize solid-state devices for rectification	U, R, Ap	1
CO-2	Understand different amplifier circuits	U, Ap	1
CO-3	Understand positive and negative feedback circuits	U	1
CO-4	Understand the concept and applications of operational amplifiers.	U, Ap	1
CO-5	Familiarise digital electronics principles	U, R	1
CO-6	Fabrication of elementary electronic circuits	Ap	3

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: BASIC ELECTRONICS

Credits: 3:0:1 (Lecture: Tutorial: Practical)

CO No.	CO	PO / PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Familiarize solid-state devices for rectification	PO1/ PSO1	U, R, Ap	F, C	L	-
CO-2	Understand different amplifier circuits	PO1/ PSO1	U, Ap	C	L	-
CO-3	Understand positive and negative feedback circuits	PO1/ PSO1	U	C	L	-
CO-4	Understand the concept and applications of operational amplifiers.	PO 1/ PSO1	U, Ap	F, C	L	-
CO-5	Familiarise digital electronics principles	PO 1/ PSO 1	U, R	F, C	L	-
CO-6	Fabrication of elementary electronic circuits	PO 1/ PSO 3	Ap	P	-	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO-1	2	-	-	-	-	-	-	2	-	-	-	-	-	-	-
CO-2	2	-	-	-	-	-	-	2	-	-	-	-	-	-	-
CO-3	2	-	-	-	-	-	-	1	-	-	-	-	-	-	-
CO-4	1	-	-	-	-	-	-	2	-	-	-	-	-	-	-

CO-5	2	-	-	-	-	-	-	2	-	-	-	-	-	-	-
CO-6	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-

Correlation Levels:

Level	**-**	**1**	**2**	**3**
Correlation	**Nil**	**Slightly / Low**	**Moderate / Medium**	**Substantial / High**

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

CO No	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO-1	✓	-	-	✓
CO-2	✓	-	✓	✓
CO-3	✓	-	-	✓
CO-4	✓	-	-	✓
CO-5	✓	-	-	-
CO-6	✓	-	-	✓

University of Kerala

Discipline	**PHYSICS**				
Course Code	**UK3DSEPHY203**				
Course Title	**FUNDAMENTALS OF ASTROPHYSICS**				
Type of Course	**DSE**				
Semester	**III**				
Academic Level	**200 - 299**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 Hrs	-	-	4 Hrs
Pre-requisites	1. Laws of motion, Familiarity with optics and light propagation 2. Knowledge of trigonometric functions and identities				
Course Summary	The course aims to give a fundamental concept of astronomy and astrophysics. This includes formation and evolution of stars and galaxies, basics of observational astronomy. On completion of the course, the student will get a comprehensive understanding of the fundamental principles and latest developments in astronomy and astrophysics.				

BOOKS FOR STUDY:

1. An Introduction to Astrophysics, Baidyanath Basu, PHI Learning Private Limited (2010)
2. Fundamentals of Astrophysics. Stan Owocki, Cambridge University Press, 2021
3. Astronomy, Andrew Fraknoi, David Morrison, and Sidney C. Wolff, XanEdu Publishing Inc; Second edition (2022)
4. Astronomy for Beginners, The introduction Guide to Space Cosmos Galaxies and Celestial Bodies, Sally R Ball ,Bluesource and Friends, 2019
5. Introduction to astronomy and cosmology, Ian Morison, Wiley
6. Introduction to Astronomy and Astrophysics, Pankaj Jain, CRC Press 2016

BOOKS FOR REFERENCE:

1. Astrophysics: Stars and Galaxies, K.D. Abhyankar, Universities Press (India) Limited (2001)
2. An Introduction to Modern Astrophysics, Bradley Carroll & Dale Ostlie Pearson Addison-Wesley, 2007
3. Modern Physics- R. Murugeshan, Kiruthika Sivaprasath (2007), S.Chand & Company Ltd
4. Introduction to Space Science – Robert C Hymes (1971), John Wiley & Sons Inc.
5. Introduction to Cosmology- J. V. Narlikar (1993), Cambridge University Press

RELATED ONLINE CONTENTS [MOOC, SWAYAM, NPTEL, Websites etc.]:

1. A Beginner's Guideto Workingwith Astronomical Data, Markus Possel (1905.13189v2.pdf (arxiv.org))
2. https://www.secretsofuniverse.in/basics-of-astrophysics-sou/

DETAILED SYLLABUS: THEORY

Module	Unit	Content	Hrs	CO No
I		**Introduction to Astronomy & Astrophysics (Book 3: Chapter 2 & 3)**	**12**	
	1	Ptolemy's model of Universe – Copernican and Galilean contributions, Branches of Astronomy	3	1
	2	Laws of planetary motion: Tycho Brahe's observations, Kepler's laws	5	1
	3	Cosmology: Expansion of the Universe - redshifts , The Big Bang and the expanding universe; dark matter and dark energy, Hubble's law	4	1
II		**Stellar Astrophysics (Book 2: Part 3)**	**12**	
	4	Celestial coordinates, Astronomical distances- Parallaxes and Parsec, Electro-magnetic spectrum, Magnitude & Types, Color, Luminosity, Color-Magnitude Diagram,	3	2
	5	Formation of stars, Estimation of Star Formation Rate	3	2
	6	Stellar evolution, White dwarfs, Supernova explosion, Neutron stars,Chandrasekhar limit, Black holes	3	2
	7	Spectral classification of stars: The Harvard classification,Yerkes Classification, M-K classification, Hertzsprung Russel diagram	3	2

III	**Galaxies (Book 2: Part 4)**		**12**	
	8	Galaxy types: Spiral, Elliptical, Dwarf, Galaxy formation	4	3
	9	Our Galaxy- Galactic structure- Galactic rotation	4	3
	10	Cepheid variables as standard candle for distances to external Galaxies, Role of Galaxy Collisions, Galactic redshift and Hubble's law	4	3
IV	**Solar system (Book 1: Chapter 5)**		**12**	
	11	Formation of solar system: Nebular hypothesis, Evolution of protoplanetary disks	4	4
	12	Growth of solid bodies, Formation of Terrestrial and Giant planets	3	4
	13	Physical characteristics of planets in solar system	2	4
	14	Familiarization of solar system objects: Satellites, Asteroid belt, Kuiper belt, Comets and Meteorites, Search for extrasolar planets	3	4
V*	**Observational Techniques in Astronomy (Book 1: Chapter 1, E-content - 1)**		**12**	
	15	Imaging techniques: photography, CCD imaging	3	5
	16	Data Acquisitionin optical, infrared, radio, x-rays, ultra-violet regions, Neutrinos and cosmic rays	2	5
	17	Telescopes and Detectors - Measuring the signal: telescope characteristics	2	5
	18	Chandra X- ray observatory, Hubble space telescope, James web Telescope, Ultra-violet Imaging telescope	2	5
	19	Familiarisation of software for data analysis - DS9, Topcat, Laxpc, Astropy, IRAF	3	5

COURSE OUTCOMES

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Recall the historical development of astronomy and astrophysics	R	3

CO-2	Identify the key concepts in astronomy and astrophysics and develop basic observational skills to identify celestial objects	R, U	3
CO-3	Differentiate between different types of galaxies and understand the structure of galaxies	U, R	3
CO-4	Describe the structure and composition of the solar system	U	3
CO-5	Explain use of telescopes and observational tools to collect and analyze astronomical data	U, Ap	3

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: FUNDAMENTALS OF ASTROPHYSICS

Credits: 4:0:0 (Lecture: Tutorial: Practical)

CO No.	CO	PO / PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Understand the historical development of astronomy and astrophysics	PO 1/ PSO 3	R	F, C	L	-
CO-2	Learn the key concepts in astronomy and astrophysics and Develop basic observational skills to identify celestial objects	PO 1/ PSO 3	U	F,C	L	-
CO-3	Differentiate between different types of galaxies and understand the structure of galaxies	PO 1/ PSO 3	U	F,C	L	-
CO-4	Gain knowledge about the structure and composition	PO 1/ PSO 3	U	F,C	L	-

	of the solar system					
CO-5	Understand the use of telescopes and observational tools to collect and analyse astronomical data	PO 2/ PSO 3	U	F,C	L	-

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**
CO-1	-	-	2	-	-	-	-	1	-	-	-	-	-	-	-
CO-2	-	-	2	-	-	-	-	1	-	-	-	-	-	-	-
CO-3	-	-	2	-	-	-	-	1	-	-	-	-	-	-	-
CO-4	-	-	2	-	-	-	-	1	-	-	-	-	-	-	-
CO-5	-	-	3	-	-	-	-	-	2	-	-	-	-	-	-

Correlation Levels:

Level	**-**	**1**	**2**	**3**
Correlation	Nil	Slightly / Low	Moderate / Medium	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

CO No	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO-1	✓	✓	-	✓
CO-2	✓	-	-	✓
CO-3	✓	-	-	✓
CO-4	✓	-	-	✓
CO-5	✓	✓	-	-

University of Kerala

Discipline	**PHYSICS**				
Course Code	**UK4DSCPHY200**				
Course Title	**CLASSICAL DYNAMICS**				
Type of Course	**DSC**				
Semester	**IV**				
Academic Level	**200 - 299**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 Hrs	-	2 Hrs	5 Hrs
Pre-requisites	1. Knowledge about Newton's laws and their implications. 2. Basic knowledge about a simple pendulum, centre of mass and oscillations				
Course Summary	The course has the following major objectives: 1. Gain deeper understanding of classical mechanics: Consolidate the understanding of concepts in mechanics such as Lagrangian, Hamiltonian, central force field, relativity and small oscillations. 2. Advance skills and capability for formulating and solving problems: applications of LaGrange's and Hamilton's equations of motion, motion in central force field, theory of relativity and the theory of small oscillations. 3. Expand and exercise the students' physical intuition and thinking process through the understanding of the theory and application of this knowledge of classical mechanics to the solution of practical problems.				

BOOKS FOR STUDY:

1. Classical Mechanics: G. Aruldhas, PHI Learning Pvt Ltd., 2008.
2. Classical Mechanics: J. C. Upadhyaya, Himalaya Publishing House.,2005.
3. Mechanics: H. S. Hans and S. P. Puri, Tata-McGraw Hill.,1984

BOOKS FOR REFERENCE:

1. Classical Mechanics, Goldstein, C.P. Poole, J.L. Safko, 3rd Edition. 2002, Pearson Education
2. Introduction to Special Relativity: R. Resnick, John Wiley and Sons, 2005.
3. Solved Problems in classical Mechanics, O.L. Delange and J. Pierrus, 2010, Oxford Press
4. Classical Mechanics, P.S. Joag, N.C. Rana, 1st Edition., McGraw Hill

DETAILED SYLLABUS: THEORY

Module	Unit	Content	Hrs	CO No
I		**Lagrangian Dynamics (Book 2: Chapter 2 and Book1: Chapter 3)**	**09**	
	1	A brief review of Newtonian mechanics of a particle and a system particle	1	1
	2	Constraints and generalized coordinates	1	1
	3	Principle of virtual Work and D' Alembert's principle	1	1
	4	Lagrange's equation from D'Alembert's Principle, Comparison between Newtonian and Lagrangian dynamics	3	1
	5	Applications of Lagrange's equation in simple pendulum, Atwood's machine and compound pendulum	3	1
II		**Hamiltonian Dynamics (Book 2: Chapter 3)**	**09**	
	6	Generalized momentum and cyclic coordinates	1	2
	7	Hamiltonian function and Conservation of energy	2	2
	8	Hamilton's equation	2	2
	9	Examples of Hamiltonian dynamics: Equation of motion of i) one dimensional harmonic oscillator ii) particle in central force field	3	2
	10	Comparison between Hamiltonian and Lagrangian dynamics	1	2
III		**Motion in Central Force Field (Book 2: Chapter 4 and Book1: Chapter 5)**	**09**	
	11	Reduction to one body problem-equations of motion-equivalent one-dimensional problem	2	3

	12	Differential equation for the orbit in the case of integrable power law potentials	2	3
	13	Virial theorem	1	3
	14	Kepler's problem	2	3
	15	Inverse square law of force	2	3
IV	**Special Theory of Relativity (Book 2: chapters 1, 11 & 12 and Book 3: chapters 10, 11 & 12)**		**09**	
	16	Inertial and non- inertial frames of reference, Galilean transformations	1	4
	17	Ether Hypothesis, The Michelson-Morley experiment and explanation of negative result	1	4
	18	Postulates of special theory of relativity and Lorentz transformations.	2	4
	19	Consequences of Lorentz transformations- length contraction, simultaneity, time dilation, twin paradox	3	4
	20	Addition of velocities, Variation of mass with velocity– mass energy relation	2	4
V*	**Theory of Small Oscillations Book1: Chapter 9 and Book2: Chapter 9**		**09**	
	21	Equilibrium and potential energy	3	5
	22	Theory of small oscillations-normal modes	4	5
	23	Two coupled pendula	2	5

DETAILED SYLLABUS: PRACTICALS

Part A – At least 5 Experiments to be performed		**CO No**
Sl No	**Name of Experiment**	
1	Verification of Newton's second law using an Air Track	6
2	Verification of conservation principles (momentum and energy) using a friction free metal track.	6

3	To determine g and velocity for a freely falling body using Digital Timing Technique	6
4	Estimation of the value of "g" using a Kater's pendulum.	6
5	Estimation of the moment of inertia about the different axes of a bifilar suspension.	6
6	Estimation of the Rigidity modulus of a metallic wire using a torsion pendulum.	6
7	Estimation of the moment of inertia of a Fly wheel (Calculate percentage error and standard deviation).	6
8	Estimation of acceleration due to gravity and Radius of gyration using Compound pendulum (Symmetric)	6
9	Estimation of acceleration due to gravity and Radius of gyration using Compound pendulum (Asymmetric)	6
10	Estimation of the Rigidity modulus of a metallic wire using a torsion pendulum with two equal masses	6
Part B* – At least One Experiment to be performed		
11	Numerical interpolation using Newton and Lagrangian methods	6
12	Study of motion of projectile in a central force field	6
13	Study of Planetary motion and Kepler's laws	6
14	Symplectic integration for linear harmonic oscillator	6
15	Solve the simple harmonic oscillator problem with /without damping and visualize the phase-space diagram.	6

COURSE OUTCOMES

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	To define generalised coordinates, generalised velocities, and generalised force and write Lagrangian for mechanical system in terms of generalised coordinates.	R, U, Ap	PSO-1,2

CO-2	To write Hamiltonian for mechanical systems and derive and solve Hamilton's equation of motion for simple mechanical systems.	R, U, Ap	PSO-1,2
CO-3	To define equations of motion corresponding to reduction to one body problem and to derive equation for orbit and learn about Virial theorem, Kepler's problem and inverse square law of force.	R, U, Ap	PSO-1,2
CO-4	Recapitulate and learn the special theory of relativity and postulates of the special theory of relativity and develop applications of special theory of relativity to dynamical systems of particles.	R, U, Ap	PSO-1,2
CO-5	Formulate the problem of small amplitude oscillation and solve them to obtain normal modes of oscillation and their frequencies in simple mechanical systems.	R, U, Ap	PSO-1,2
CO-6	Able to do simple experiments related to applications of classical dynamics and to perform simple computer programs related to applications of classical dynamics.	U, Ap	PSO-5,7

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: CLASSICAL DYNAMICS

Credits: 3:0:1 (Lecture: Tutorial: Practical)

CO No.	**CO**	**PO / PSO**	**Cognitive Level**	**Knowledge Category**	**Lecture (L)/ Tutorial (T)**	**Practical (P)**
CO-1	To define generalised coordinates, generalised velocities, and generalised force and write Lagrangian for mechanical system	PO-1,2,3,4,5, 6,8/ PSO-1,2	R, U, Ap	F, C	L	-

	in terms of generalised coordinates.					
CO-2	To write Hamiltonian for mechanical systems and derive and solve Hamilton's equation of motion for simple mechanical systems.	PO-1,2,3,4,5,6,8/ PSO-1,2	R, U, Ap	F, C	L	-
CO-3	To define equations of motion corresponding to reduction to one body problem and to derive equation for orbit and learn about Virial theorem, Kepler's problem and inverse square law of force.	PO-1,3,4,5,6,8/ PSO-1,2	R, U, Ap	F, C	L	-
CO-4	Recapitulate and learn the special theory of relativity and postulates of the special theory of relativity and develop applications of special theory of relativity to dynamical systems of particles.	PO-1,3,4,5,6,8/ PSO-1,2	R, U, Ap	F, C	L	-

CO-5	Formulate the problem of small amplitude oscillation and solve them to obtain normal modes of oscillation and their frequencies in simple mechanical systems.	PO-1,3,4,5,6,8/ PSO-1,2	R, U, Ap	F, C	L	-
CO-6	To do simple experiments related to applications of classical dynamics and to perform simple computer programs related to applications of classical dynamics.	PO-1,2,3,6,7/ PSO-5,7	U, Ap	P	-	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO-1	2	2	-	-	-	-	-	2	-	3	2	2	2	-	2
CO-2	2	2	-	-	-	-	-	3	-	2	2	2	2	-	3
CO-3	2	2	-	-	-	-	-	2	-	2	2	2	2	-	3
CO-4	2	2	-	-	-	-	-	2	-	2	2	2	2	-	2
CO-5	2	2	-	-	-	-	-	2	-	2	2	2	2	-	2
CO-6	-	-	-	-	2	-	3	2	2	3	3	2	-	2	2

Correlation Levels:

Level	-	1	2	3
Correlation	Nil	Slightly / Low	Moderate / Medium	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

CO No	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO-1	✓	-	-	✓
CO-2	✓	✓	-	✓
CO-3	✓	✓	-	✓
CO-4	✓	✓	-	✓
CO-5	✓	-	-	✓
CO-6	✓	-	-	-

University of Kerala

Discipline	**PHYSICS**				
Course Code	**UK4DSCPHY201**				
Course Title	**ELECTROMAGNETICS AND TRANSIENT CURRENTS**				
Type of Course	**DSC**				
Semester	**IV**				
Academic Level	**200 - 299**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 Hrs	-	2 Hrs	5 Hrs
Pre-requisites	Basics of electrostatics				
Course Summary	This course aims to provide a strong foundation to the principles of electrostatics and magnetostatics and equip the students to be familiar with the theoretical basis of electrodynamics. The course also provides hands on experience in handling different electrical circuits.				

BOOKS FOR STUDY:

1. Electrodynamics: David J Griffith, PHI, 3rd Edn.
2. Electricity and Magnetism:Murugesan, S.Chand & Co.
3. Electricity and Magnetism: K.K.Tiwari, S.Chand & Co. 4. Principles of lectromagnetics: Matthew N.O. Sadiku and S. V. Kulkarni, Oxford University Press, 6th Edn.

BOOKS FOR REFERENCE:

1. Electricity and Magnetism: E.M. Purcell, Berkley Physics course, Vol.2, MGH
2. Classical Electromagnetic Theory, Jack Vanderlinde, Second Edition, Kluwer Academic Publishers, 2004
3. Classical Electrodynamics: Walter Greiner, Springer International Edn.

4. Electricity and Magnetism: Muneer H. Nayfeh & Norton K. Bressel, John Wiley & Sons
5. Electricity and Magnetism: J.H. Fewkes & John Yarwood, University Tutorial Press
6. Electromagnetic waves and radiating systems: Jordan & Balmain, PHI
7. Electromagnetics: B.B.Laud, Wiley Eastern Ltd., 2ndEdn.
8. Introduction to electrodynamics: Reitz & Milford Addison Wesley
9. Electromagnetic theory fundamentals: Bhag Guru and Huseyin Hizirogulu, Cambridge University Press, 2nd Edn.
10. Electricity and Magnetism: D.C.Tayal, Himalaya Publishing Co.

DETAILED SYLLABUS: THEORY

Module	Unit	Content	Hrs	CO No
I		**ELECTROSTATIC FIELD**	**9**	
	1	Coulomb's law, Electric field due continuous charge distribution	2	1
	2	Field lines, flux, Gauss's law, Divergence and Curl of electrostatic fields.	2	1
	3	Electric potential, Poisson's and Laplace's equations, Potential of a localized charge distribution.	2	1
	4	Work and Energy in Electrostatics: The work done to move a charge, Energy of a point charge distribution, The energy of a continuous charge distribution	2	1
	5	Electrostatic boundary conditions	1	1
II		**ELECTROSTATIC FIELD IN MATTER**	**9**	
	6	Polar and Nonpolar molecules, Induced dipole and polarizability. Alignment of polar molecules in uniform and nonuniform electric field.	2	2
	7	Polarization in a Dielectric Material, The field of a polarized object: Bound and Free Charges, Bound Charge Density, Physical interpretation of bound charges	3	2
	8	Electric displacement, Gauss's law in presence of dielectric.	2	1, 2
	9	Boundary conditions, Linear Dielectrics	2	2

III	**MAGNETOSTATICS**		**9**	
	10	Lorentz Force, Electric Current- surface current density, volume current density, Equation of continuity.	2	3
	11	The Biot- Savarts law, Applications-Magnetic field due to long wire and circular loop	2	3
	12	Magnetic flux, Gauss's law in magnetism, Divergence of B (Physical interpretation only)	1	3
	13	Ampere's circuital theorem, Curl of B (Physical interpretation only), Applications- Magnetic field due to Solenoid and Toroid	2	3
	14	Magnetic vector potential.	1	3
	15	Boundary conditions	1	3
IV	**ELECTROMAGNETIC INDUCTION**		**9**	
	16	Electromagnetic Induction, Faraday's law, Lenz's law, Motional e m f, Induced electric field	2	4
	17	Self - inductance and Mutual inductance, back e m f	1	4
	18	Maxwell's equation, correction of Ampere's circuital theorem,	2	4
	19	Waves in one dimension: Wave equation of electromagnetic waves in vacuum, propagation of electromagnetic waves through vacuum and linear dielectric media	3	5
	20	Monochromatic planes waves, Energy and Momentum in EM waves	1	5
V*	**TRANSIENT CURRENTS**		**9**	
	21	Growth and decay of current in LR Circuit	2	6
	22	Growth and decay of current in CR Circuit	2	6
	23	Measurement of high resistance by leakage	1	6
	24	Charging of a capacitor through LCR circuit.	2	6
	25	Discharging of a capacitor through LCR circuit.	2	6

DETAILED SYLLABUS: PRACTICALS

Part A – At least 5 Experiments to be performed		**CO No**
Sl No	**Name of Experiment**	
1	Potentiometer- Resistivity	6
2	Potentiometer –Calibration of ammeter	6
3	Carey Foster's Bridge-Resistivity	6
4	Carey Foster's Bridge-Temperature coefficient of resistance.	6
5	Mirror galvanometer-figure of merit.	6
6	BG- Absolute capacity of a condenser	6
7	Conversion of galvanometer into ammeter and calibration using digital Multimeter	6
8	Circular coil-Calibration of ammeter.	6
9	Absolute determination of m and B_h using box type and Searle's type vibration magnetometers	6
10	Searle's vibration magnetometer-comparison of magnetic moments.	6
11	Potentiometer – Calibration of high range voltmeter	6
12	Potentiometer - Reduction factor of TG	6
Part B* – At least One Experiment to be performed		
13	. Potentiometer –Calibration of low range voltmeter	6
14	Study of network theorems-Thevenin's & Norton's theorems and maximum power transfer theorem	6
15	Thermo emf- Measurement of thermo emf of thermocouple (Seebeck effect)	6
16	Circular coil-Study of earth's magnetic field using compass box.	6
17	Conversion of galvanometer into voltmeter and calibration using digital Multimeter.	6

COURSE OUTCOMES

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Identify the principles of electrostatics and apply it to the solutions of problems relating to electric field and electric potential and boundary conditions	U, Ap	PSO-1,2,3
CO-2	Identify the mechanism of polarization and its various effects in dielectric, by applying the principles of electrostatics.	U, Ap	PSO-1,2,3
CO-3	Identify the principles of magnetostatics and apply it to the solutions of problems relating to magnetic field and boundary conditions.	U, Ap	PSO-1,2,3
CO-4	Recognize the concepts related to Faraday ‘s law, induced emf, Maxwell ‘s equations	U, Ap	PSO-1,2,3,5
CO-5	Compare the properties of electromagnetic waves in vacuum, and matter	U, Ap	PSO-1,2,3,6
CO-6	Analyse the growth and decay of current in various electrical circuits	U, An	PSO-1,2,3

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: ELECTROMAGNETICS AND TRANSIENT CURRENTS

Credits: 3:0:1 (Lecture: Tutorial: Practical)

CO No.	CO	PO / PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Identify the principles of electrostatics and apply it to the solutions of	PSO-1,2,3	U, Ap, An	F, C	L	-

	problems relating to electric field and electric potential and boundary conditions					
CO-2	Identify the mechanism of polarization and its various effects in dielectric, by applying the principles of electrostatics.	PSO-1,2,3	U, Ap, An	C	L	-
CO-3	Identify the principles of magnetostatics and apply it to the solutions of problems relating to magnetic field and boundary conditions.	PSO-1,2,3	U, Ap, An	C	L	-
CO-4	Recognize the concepts related to Faraday ‘s law, induced emf, Maxwell ‘s equations	PSO-1,2,3,5	U, Ap, An	F, C	L	-
CO-5	Compare the properties of electromagnetic waves in vacuum, and matter	PSO-1,2,3,6	U, Ap, An	C, P	L	-

CO-6	Analyse the growth and decay of current in various electrical circuits	PSO-1,2,3	U, Ap, An	P	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO-1	3	3	2	-	-	-	-	2	-	-	-	-	-	-	-
CO-2	3	3	2	-	-	-	-	2	-	-	-	-	-	-	-
CO-3	3	3	2	-	-	-	-	1	-	-	-	-	-	-	-
CO-4	3	3	2	-	1	-	-	2	-	-	-	-	-	-	-
CO-5	2	3	2	-	-	3	-	2	-	-	-	-	-	-	-
CO-6	2	3	2	-	-	-	-	2	-	-	-	-	-	-	-

Correlation Levels:

Level	-	1	2	3
Correlation	Nil	Slightly / Low	Moderate / Medium	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

CO No	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO-1	✓	-	-	✓
CO-2	✓	✓	-	✓
CO-3	✓	✓	-	✓
CO-4	✓	✓	-	✓
CO-5	✓	-	-	✓
CO-6	✓	-	-	-

University of Kerala

Discipline	**PHYSICS**				
Course Code	**UK4DSEPHY205**				
Course Title	**C++ PROGRAMMING FOR PHYSICS**				
Type of Course	**DSE**				
Semester	**IV**				
Academic Level	**200 - 299**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 Hrs	-	2 Hrs	5 Hrs
Pre-requisites	-				
Course Summary	This course discusses basic programming concepts in C++. Students will get an understanding of programming logic in C++. Discussion on conditional statements, loops, arrays and functions will allow students to write any simple programs in C++.				

BOOKS FOR STUDY:

1. Programming with C++, D. Ravichandran, Third edition, Tata McGraw Hill, 2011

BOOKS FOR REFERENCE:

1. Object oriented programming with C++, E Balaguruswami 5th Edition, Tata McGraw Hill
2. The C++ programming language, Biome Stroustrup, Addison Wiley
3. Programming in C++, M T Somasekharan, PHI PVT Publishing, 2005

DETAILED SYLLABUS: THEORY

Module	Unit	Content	Hrs	CO No
I		**Basics of C++**	**9**	
	1	Object-oriented programming, Characteristics of OOPs, Advantages of OOPs, Disadvantages of OOPs	3	1, 4

	2	Compiling and debugging C++ programs	1	2
	3	Identifiers and keywords, C++ simple data types, variables, constants	2	2
	4	C++ operators- arithmetic operator - assignment operator, logical operators, bitwise operator, special operators	3	2
II	**Conditional Statement and Loops in C++**		**10**	
	5	Conditional expressions, if statement, if else statement, nested if else - switch-case	4	2, 3, 5
	6	Loop statements: for loop, while loop, do-while loop	4	2, 3, 5
	7	Breaking control statements: goto statement, break statement, continue statement	2	3, 5
III	**Arrays and pointers**		**8**	
	8	Array declaration, Array initialisation, Multidimensional array, Character array	3	3, 5
	9	Pointer declaration, pointer operation, address operator, pointer expression	3	3
	10	Pointers and arrays, pointers and strings	2	3
IV	**Functions in C++**		**9**	
	11	Defining a function, function prototypes	3	2, 3, 5
	12	Local vs global variables, nested functions, scope rules	4	3
	13	Recursive functions, standard functions	2	3, 5
V*	**Classes in C++**		**9**	
	14	Structure and class, Declaration of a class, member functions	4	1, 4
	15	defining object of a class, accessing member of a class, array of class objects, pointers and classes	5	4

DETAILED SYLLABUS: PRACTICALS

Part A – At least 5 Experiments to be performed		**CO No**
Sl No	**Name of Experiment**	
1	Program to find Cross product and fit product of two vectors	5
2	Program to check whether the entered number is prime or not	5
3	Program to list values of sin(x), tan(x) and exp(x) for a range of x values.	5
4	Program to display factors of a number	5
5	Program to convert given number to binary number	5
6	Program to find roots of a quadratic equation	5
7	Program to calculate range and maximum height of a projectile	5
8	Program to display sum and difference of two matrices	5
9	Program to find factorial of a number using functions	5
10	Program to find reduced mass and centre of mass of two spherical objects	5
Part B* – At least One Experiment to be performed		
11	Program to enter name and marks of n students and to generate rank list	5
12	Program to multiply two matrices	5
13	Program to enter names of n students and to sort them alphabetically.	5
14	Program to manage inventory of a supermarket with name, quantity and price of items.	5

COURSE OUTCOMES

No.	**Upon completion of the course the graduate will be able to**	**Cognitive Level**	**PSO addressed**
CO-1	Gain knowledge about object oriented programming concept in C++	R, U	2, 5, 7
CO-2	Identify the structure and basic elements of a C++	R,U	2, 5, 7

	program		
CO-3	Use the concepts of conditional statements, loops and functions to write simple programs in C++ and acquire basic programming logic	U, Ap	2, 5, 7
CO-4	Describe the concepts of classes and objects	U, Ap	2, 5, 7
CO-5	Write programs in C++ to solve basic problems.	U, Ap	2, 5, 7

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: C++ PROGRAMMING FOR PHYSICS

Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	**CO**	**PO/PSO**	**Cognitive Level**	**Knowledge Category**	**Lecture (L)/ Tutorial (T)**	**Practical (P)**
CO-1	Gain knowledge about object oriented programming concept in C++	PSO 2, 5, 7 / PO 1, 2, 3, 7	R, U	F, C	L	-
CO-2	Identify the structure and basic elements of a C++ program	PSO 2, 5, 7 / PO 1, 2, 3, 7	R,U	F, C	L	-
CO-3	Use the concepts of conditional statements, loops and functions to write simple programs in C++ and acquire basic programming logic	PSO 2, 5, 7 / PO 1, 2, 3, 7	U, Ap	F, C	L	-

CO-4	Describe the concepts of classes and objects	PSO 2, 5, 7 / PO 1, 2, 3, 7	U, Ap	F, C	L	-
CO-5	Write programs in C++ to solve basic problems.	PSO 2, 5, 7 / PO 1, 2, 3, 7	U, Ap	F, C, P	-	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO-1	-	2	-	-	1	-	1	1	1	1	-	-	-	1	-
CO-2	-	2	-	-	2	-	2	1	2	1	-	-	-	2	-
CO-3	-	3	-	-	1	-	1	1	2	1	-	-	-	2	-
CO-4	-	2	-	-	1	-	1	1	1	1	-	-	-	1	-
CO-5	-	2	-	-	3	-	7	2	3	2	-	-	-	3	-

Correlation Levels:

Level	-	1	2	3
Correlation	Nil	Slightly / Low	Moderate / Medium	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

CO No	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO-1	✓	-	-	✓
CO-2	✓	-	-	✓
CO-3	✓	-	-	✓
CO-4	✓	✓	-	-
CO-5	✓	✓	-	-

University of Kerala

Discipline	**PHYSICS**				
Course Code	**UK5DSCPHY300**				
Course Title	**OPTICS**				
Type of Course	**DSC**				
Semester	**V**				
Academic Level	**300 - 399**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 Hrs	-	2 Hrs	5 Hrs
Pre-requisites	-				
Course Summary	Optics, a branch of physics dedicated to the study of light, delves into a myriad of phenomena such as interference, where light waves interact to form distinct patterns of constructive and destructive interference. Diffraction, another fundamental aspect, elucidates the bending of light waves around obstacles or through small apertures, altering their propagation paths. Furthermore, dispersion unveils the separation of light into its constituent wavelengths. Finally, polarization explores the alignment of light waves along specific planes, influencing various optical properties.				

BOOKS FOR STUDY:

1. Optics by Ajoy Ghatak 7th edition
2. Text Book of Optics: Subramaniam & Brijlal
3. Optics and spectroscopy: R.Murugesan and K Sivaprasad, S. Chand & Co., 2010

BOOKS FOR REFERENCE:

1. Optics: Eugene Hecht, Addison-Wesley 2002
2. Basic optics: principles and concepts: Avijit Lahiri, Elsvier
3. Lasers-Principles, types and applications, K R Nambiar

DETAILED SYLLABUS: THEORY

Module	Unit	Content	Hrs	CO No
I		**Interference of light**	**9**	
	1	The principle of superposition - coherent sources – superposition of waves from coherent and incoherent sources, Young's double slit experiment	2	1
	2	Interference by division of wave front-Fresnel's biprism	2	1
	3	Interference by division of amplitude -interference in thin films (reflection only), colours in thin films, air wedge testing of optical flatness	3	1
	4	Newton's rings (reflected system)-refractive index of a liquid	2	1
II		**Fresnel Diffraction**	**9**	
	5	Introduction, Huygens theory, Fresnel and Fraunhofer diffractions.	1	1,2
	6	Fresnel diffraction: Fresnel's assumptions, Half-period zones, - explanation of rectilinear propagation of light	2	1,2
	7	Diffraction at a straight edge	2	2
	8	Zone plate-Comparison between zone plate and convex lens.	2	2
III		**Fraunhofer diffraction**	**9**	
	9	Introduction, Diffraction at a single slit	1	2
	10	Diffraction through a circular aperture	2	2
	11	Diffraction through double slits and N-slits	2	2
	12	Diffraction grating	2	2
	13	Limit of resolution, Rayleigh's criterion for resolution, resolving power of microscope and grating.	2	2
IV		**Polarisation and Dispersion**	**9**	
	14	Polarization, Plane polarized light, Malus law	1	4

	15	Polarization by reflection, Brewster's law	1	4
	16	Double refraction, positive and negative crystals, Nicol prism-construction, Nicol prism as a polarizer and analyzer	3	4
	17	Quarter and half wave plates. Theory- production and analysis of plane, circularly and elliptically polarized light.	3	4
	18	Dispersion: Normal and anomalous dispersion-Cauchy's relation (Qualitative ideas only).	1	3
V*	**Lasers**		**9**	
	19	Laser beam characteristics, spatial and temporal coherence (qualitative ideas)	1	5
	20	Basic principle of laser operation, spontaneous and stimulated emission, Einstein coefficient	2	5
	21	Light propagation through medium and condition for light amplification, metastable state and population inversion, pumping and optical resonant cavity	2	5
	22	Ruby laser , He-NE laser and semiconductor laser	3	5
	23	Application of lasers.	1	5

DETAILED SYLLABUS: PRACTICALS

Part A – At least 5 Experiments to be performed		**CO No**
Sl No	**Name of Experiment**	
1	Spectrometer-A, D and n of a solid prism	6
2	Spectrometer –Dispersive power and Cauchy's constants	6
3	Spectrometer Grating—Normal incidence- N & wavelength	6
4	Spectrometer-i-d curve	6
5	Spectrometer- Hollow prism	6
6	Liquid lens-refractive index of liquid and lens	6

7	Newton's Rings—Reflected system	6
8	Air wedge-diameter of a wire	6
9	Method of parallax: optical constants of convex lens i. using mirror and mercury ii. using mirror and water	6
10	Method of parallax: refractive index of a liquid	6
Part B* – At least One Experiment to be performed		
11	a. Laser beam characteristics b. Diffraction grating b. Diffraction at different types of slits and apertures	6
12	Refractive index of liquids and liquid mixtures using Abbe's refractometer	6
13	Optical activity studies using Polarimeters	6

COURSE OUTCOMES

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Describe the different basic phenomena of light such as Interference, Diffraction, Dispersion and Polarization	U	PSO-1,2,3
CO-2	Relates diffraction theory in Rayleigh's criterion for resolution and in finding resolving power of diffraction grating	U, Ap	PSO-1,2,3
CO-3	Explain the phenomenon- dispersion	U	PSO-1,2,3
CO-4	Differentiate the different types of polarizations, its theory and the production/analysis methods and apply the concept in studying Nicol prism, quarter wave and half wave plates	U, Ap, An	PSO-1,2
CO-5	Explain the basic constituents of a laser, different types and working	U	PSO-1,2

CO-6	Apply various optical instruments and techniques to analyse and manipulate light, including lenses, mirrors, prisms, and optical fibers.	U, Ap	PSO-2, 7

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: OPTICS

Credits: 3:0:1 (Lecture: Tutorial: Practical)

CO No.	**CO**	**PO / PSO**	**Cognitive Level**	**Knowledge Category**	**Lecture (L)/ Tutorial (T)**	**Practical (P)**
CO-1	Describe the different basic phenomena of light such as Interference, Diffraction, Dispersion and Polarization	PO-1, 2 PSO-1,2,3	U	F, C	L	-
CO-2	Relates diffraction theory in Rayleigh's criterion for resolution and in finding resolving power of diffraction grating	PO-1, 2 PSO-1,2,3	U, Ap	C,P	L	-
CO-3	Explain the phenomenon-dispersion	PO-1, 2 PSO-1,2,3	U	F, C	L	-
CO-4	Differentiate the different types of polarizations, its theory and the production/analysis	PO-1, 2 PSO-1,2	U,Ap, An	F, C	L	-

	methods and apply the concept in studying Nicol prism, quarter wave and half wave plates					
CO-5	Explain the basic constituents of a laser, different types and working	PO-1, 2 PSO-1,2	U	F, C	L	-
CO-6	Apply various optical instruments and techniques to analyse and manipulate light, including lenses, mirrors, prisms, and optical fibers.	PO-1, 2 PSO-2,7	U, Ap	F, C,P	T	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO-1	2	2	1	-	-	-	-	3	2	-	-	-	-	-	-
CO-2	2	2	3	-	-	-	-	3	2	-	-	-	-	-	-
CO-3	1	2	1	-	-	-	-	3	2	-	-	-	-	-	-
CO-4	3	1	-	-	-	-	-	3	2	-	-	-	-	-	-
CO-5	3	2	-	-	-	-	-	3	2	-	-	-	-	-	-
CO-6	-	2	-	-	-	-	2	3	2	-	-	-	-	-	-

Correlation Levels:

Level	-	1	2	3
Correlation	Nil	Slightly / Low	Moderate / Medium	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics:

CO No	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO-1	✓	✓	-	✓
CO-2	✓	-	-	✓
CO-3	✓	-	-	✓
CO-4	✓	-	✓	✓
CO-5	✓	✓	-	-
CO-6	✓	-	-	-

University of Kerala

Discipline	**PHYSICS**				
Course Code	**UK5DSCPHY301**				
Course Title	**QUANTUM MECHANICS I**				
Type of Course	**DSC**				
Semester	**V**				
Academic Level	**300 - 399**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 Hrs	-	-	4 Hrs
Pre-requisites	● The students should have a basics understanding of elementary classical mechanics ● The students should have basic ideas in electricity and magnetism ● The students be familiar with the fundamentals of algebra and trigonometry, vectors, matrices, complex numbers, ordinary differential and integral calculus				
Course Summary	This course aims to present the basics of quantum mechanics in an easily understandable way. The course begins with an introduction to limitations of classical mechanics and the emergence of quantum mechanics. The second module comprises of the basic ideas of wave packets and wave functions. The Schrodinger equation, operators, eigenfunctions etc are discussed in the third module. One dimensional eigen value problems and a glossary of the approximate methods is described with a few examples in the fourth module. Finally, general formalism of quantum mechanics and various operators are also presented.				

BOOKS FOR STUDY:

1. Concepts of Modern Physics: Arthur Beiser, Mc Graw Hills
2. Introduction to Quantum Mechanics : David, J Griffith, Prentice Hall
3. Quantum Mechanics : G Aruldhas, PHI, 2nd Edition, 2020
4. Quantum Mechanics, Bransden and Joachain, 2nd Edition, Pearson education Ltd.,2000

BOOKS FOR REFERENCE:

1. Quantum Mechanics Theory and Applications-Ajoy Ghatak, S Lokanathan , 5th Edn
2. Quantum Mechanics-Leonard I Schiff ,3rd Edn
3. Quantum Mechanics-V K Thankappan , 5th Edn
4. Principles of Quantum Mechanics-R Shankar, 2nd Edn

WEB RESOURCES:

1. **https://nptel.ac.in/courses/115101010**

DETAILED SYLLABUS: THEORY

Module	Unit	Content	Hrs	CO No
I	**Limitations of Classical Physics and Emergence of Quantum theory (Book :1, Chapter-2 & 4; Book: 4, Chapter-1)**		**12**	
	1	Black Body Radiation	4	1
	2	Photoelectric Effect	2	1
	3	Compton effect	2	1
	4	Bohr atom model	2	1
	5	Stability of atoms, Atomic spectra, Correspondence Principle	2	1
II	**Wave packets and wave functions (Book:1, Chapter-3; Book:2- Chapter 1; Book:3, Chapter-2; Book:4, Chapter-2)**		**12**	
	1	Wave particle duality, de Broglie Wave, Electron diffraction - Experimental confirmation	3	3
	2	Wave packet, group velocity, phase velocity	2	2

	3	Wave functions, properties of wave function, statistical interpretation and normalisation of wave functions	3	2
	4	de Broglie's explanation for Bohr's quantisation condition for angular momentum, Application of wave nature of electrons - electron microscope	2	2
	5	Uncertainty Principle and its applications- non existence of electron inside the nucleus, width of spectral lines	2	2
III	**Schrodinger Equation (Book:2- Chapter 1; Book:3, Chapter-2 & 3; Book:4, Chapter-3)**		**12**	
	1	Postulates of Quantum Mechanics: wave functions, superposition principle, physical quantities and their operators (position, momentum, angular momentum, time and energy), expectation value, eigen functions and eigenvalues, time evolution of wave function	2	4
	2	Time dependent Schrodinger Equation	3	4
	3	Time independent Schrodinger equation and stationary states	3	5
	4	Commutation operation: properties, operator form of uncertainty principle	2	5
	5	General uncertainty relation	2	5
IV	**One Dimensional energy eigen value problems (Book:2, Chapter2; Book:3, Chapter-4; Book:4, Chapter-4)**		**12**	
	1	Free particle	2	5
	2	Particle in infinite square well potential (particle in a box), energy levels for particle in a box problem	3	5
	3	Particle in finite square well potential	4	5
	4	Finite square barrier potential (No Derivation), Ideas of Quantum Tunnelling	2	5
	5	Harmonic oscillator (No Derivation), Energy expression	1	5
V*	**Mathematical Formulation of quantum mechanics (Book:3, Chapter 3; Book:4, Chapter-5)**		**12**	
	1	Linear vector space, linear operators, Dirac Notation	4	6

	2	Hilbert space – properties	2	6
	3	Hermitian operators: properties and examples	2	6
	4	Unitary operators: properties and general form	2	6
	5	Schrodinger's cat paradox	2	3

COURSE OUTCOMES

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Recognize the limitations of Classical Physics and to understand the quantum concept-based explanation.	U	PSO-1
CO-2	Identify the properties and quantum mechanical concepts applicable to Physical systems	U	PSO-1,2
CO-3	Learn the physical and mathematical concepts of quantum physics	U	PSO-1,2
CO-4	Apply the concept of quantum mechanics to derive equations and solve problems	Ap	PSO-1,2
CO-5	Employ the quantum mechanical concept to explain certain physical phenomena and Analysis of specific problems.	Ap,An	PSO-1,2
CO-6	Application and evaluation of the operators to explain various physical states	U, Ap	PSO-1,2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: QUANTUM MECHANICS I

Credits: 4:0:0 (Lecture: Tutorial: Practical)

CO No.	CO	PO / PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Recognize the limitations of Classical Physics and to understand the quantum concept-based explanation.	PO1/ PSO1	U	F, C	L	-
CO-2	Identify the properties and quantum mechanical concepts applicable to Physical systems	PO1/ PSO1,2	U	C	L	-
CO-3	Learn the physical and mathematical concepts of quantum physics	PO1/ PSO1,2	U	C	L	-
CO-4	Apply the concept of quantum mechanics to derive equations and solve problems	PO2/ PSO1,2	Ap	C	L	-
CO-5	Employ the quantum mechanical concept to explain certain physical phenomena and Analysis of specific problems.	PO2/ PSO1,2	Ap, An	C	L	-
CO-6	Application and evaluation of the operators to explain various physical states	PO1/PSO 1,2	U, Ap	F, C	L	-

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PS	PS	PS	PS	PS	PS	PS	PO	PO	PO	PO	PO	PO	PO	PO
CO-1	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-
CO-2	2	2	-	-	-	-	-	2	-	-	-	-	-	-	-
CO-3	2	2	-	-	-	-	-	2	-	-	-	-	-	-	-
CO-4	2	1	-	-	-	-	-	-	1	-	-	-	-	-	-
CO-5	2	3	-	-	-	-	-	-	3	-	-	-	-	-	-
CO-6	1	2	-	-	-	-	-	2		-	-	-	-	-	-

Correlation Levels:

Level	-	1	2	3
Correlation	Nil	Slightly / Low	Moderate / Medium	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics:

CO No	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO-1	✓	-	-	✓
CO-2	✓	-	-	✓
CO-3	✓	-	-	✓
CO-4	✓	✓	-	✓
CO-5	✓	✓	-	✓
CO-6	✓	✓	-	-

University of Kerala

Discipline	**PHYSICS**				
Course Code	**UK5DSCPHY302**				
Course Title	**THERMODYNAMICS AND STATISTICAL MECHANICS**				
Type of Course	**DSC**				
Semester	**V**				
Academic Level	**300 - 399**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 Hrs	-	2 Hrs	5 Hrs
Pre-requisites	1. Students should know the basic concept of heat, temperature, calorimetry, specific heat capacities and latent heat 2. Students should be aware of transfer of heat through conduction, convection, and radiation. 3. Students should be familiar with Thermal equilibrium, Zeroth law and first law of thermodynamics 4. Students should know the basics mathematics of permutations, combinations, logarithm, and Sterling's approximation				
Course Summary	● Get an essence of the basic concepts of thermodynamics, the first and the second law of thermodynamics, the concept of entropy and the associated theorems, the thermodynamic potentials, and their physical interpretations along with Maxwell's thermodynamic relations and Phase transition ● Gain the basic knowledge about the fundamentals of Statistical Mechanics, Maxwell-Boltzmann distribution law. ● Learn about thermal conductivity, black body radiations, Stefan's law, and Planck's law and their significances.				

	• In the laboratory course, the students are expected to: Measure of Planck's constant using black body radiation, coefficient of thermal conductivity of a bad conductor, determine the temperature coefficient of resistance, study variation of thermo-emf across two junctions of a thermocouple with temperature etc.

BOOKS FOR STUDY:

1. Heat and Thermodynamics and Statistical Mechanics: Brijlal , Subramaniam, P S Hemne, S. Chand &Co (2021).
2. Heat and Thermodynamics: M. Zemansky, McGraw Hill, New Delhi (2007).
3. " How things works – The Physics of everyday life" Louis A Bloomfield , 5th Edition, Wiley Publications (2013)

BOOKS FOR REFERENCE:

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

DETAILED SYLLABUS: THEORY

Module	Unit	Content	Hrs	CO No
I		**TRANSFER OF HEAT (Book 1)**	**11**	
	1	Thermoelectric effects – Seebeck, Peltier and Thomson effects, Thermoelectric power	2	3
	2	Thermal conductivity – Radial flow of heat, cylindrical flow	2	3
	3	Black body radiation – Discussion of black body radiation curve, Wein's Displacement Law, Rayleigh - Jeans Law,	3	1, 3

		Planck's Quantum Postulates- Radiation law, Stefan Boltzmann law (Proof not required).		
	4	Air conditioning System– Equipments used in Air conditioning system, Classification of Air Conditioning systems- Summer Air conditioning system, Winter Air Conditioning System.	3	1, 3
	5	Global Warming – Effects, Efforts to control Global warming	1	3
II	**THERMODYNAMICS (Book 1, 2, 3)**		**14**	
	6	Thermodynamic Equilibrium, Equation of state, Hydrostatic systems, Work in changing the volume of hydrostatic system, stretched wire, P V diagram. (Book 2)	4	3
	7	First law of thermodynamics, Thermodynamic processes – Isothermal, Adiabatic, reversible, and irreversible, Isobaric and Isochoric, adiabatic expansion of gas, cyclic processes (Basic ideas)	2	1, 3
	8	Expression for work done in isothermal and adiabatic process	1	3
	9	Carnot's Ideal Heat engine	2	3
	10	Petrol engine & Diesel engine – working and efficiency, Multi Cylinder Engines(Book 1), Diesel Engines and Turbochargers (Book3)	4	1, 3
	11	Second law of thermodynamics – Clausius and Kelvin - Planck statements, Refrigerator (Qualitative idea)	1	3
III	**ENTROPY (Book 1, 2)**		**5**	
	12	Change in entropy – physical Concept, Change of entropy in reversible and irreversible thermodynamic processes.	1	4
	13	Principle of increase of entropy, Heat Death of universe	1	1, 4
	14	T -S diagram (Book 2)	1	4
	15	Change in Entropy for the conversion of ice to steam	1	4
	16	Nernst theorem and third law of thermodynamics, Zero-point energy	1	1, 4

IV	**THERMODYNAMIC POTENTIALS AND MAXWELL'S RELATIONS (Book 1)**		**7**	
	17	Basic concept of thermodynamic variables & potentials	1	5
	18	Internal energy, enthalpy, Helmholtz free energy, Gibb's free energy – Physical Significance	1	5
	19	Relation of thermodynamic Potentials with variables - Maxwell's thermodynamic relations - Clausius - Clapeyron's Latent Heat equation	3	5
	20	Change of phase - Phase diagram – first and second order phase transitions	2	5
V*	**STATISTICAL MECHANICS (Book 1)**		**9**	
	21	Statistical Basis – Probability, Principle of equal A priory, probability	1	6
	22	Macrostates and Microstates, Phase space	1	6
	23	Density of quantum states of energy of a particle	1	6
	24	Statistical Ensembles – Microcanonical, Canonical, Grand Canonical	1	6
	25	Partition function	1	6
	26	Maxwell – Boltzmann statistics- Energy and velocity distribution – Derivation	2	6
	27	Need of Quantum statistics, Maxwell - Boltzmann statistics, Bose - Einstein statistics, Fermi - Dirac statistics – Comparative study only	2	6

DETAILED SYLLABUS: PRACTICALS

Part A – At least 5 Experiments to be performed		**CO No**
Sl No	**Name of Experiment**	
1	To determine the coefficient of thermal conductivity of Cu by Searle's apparatus.	2
2	To determine the coefficient of thermal conductivity of a bad conductor by Lee's disc method.	2

3	To determine the temperature coefficient of resistance by Carey Foster's Bridge.	2
4	To study the variation of thermo-emf across two junctions of a thermocouple with temperature.	2
5	To determine mechanical equivalent of heat, J, by Callender and Barne's constant flow method.	2
6	Determination of thermal conductivity of rubber.	2
7	Measurement of Planck's constant using black body radiation.	2
8	Characteristics of Thermistor.	2
9	Determine the specific heat capacity of water	2
10	Determine the Latent heat of fusion of ice	2
Part B* – At least One Experiment to be performed		
11	Verification of Newton's Law of Cooling.	2
12	Phase transition-determination of Melting Point of wax	2
13	To determine the temperature coefficient of resistance using Platinum Resistance Thermometer using Callender and Griffith Bridge	2

COURSE OUTCOMES

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Describe the fundamental laws of thermal Physics, Thermodynamics and Statistical Mechanics and interpret its significance.	U, Ap	PSO - 1
CO-2	Identify the thermal properties, applications of heat transfer, various thermodynamic processes and judge the efficiency of engines by comparing the performance of various vehicles	R, U, Ap	PSO-1,2
CO-3	Distinguish entropy and available energy in various thermodynamic processes and illustrate various phase transitions	U, Ap	PSO – 1, 2

CO-4	Describe thermodynamic variables, thermodynamic potentials, and its physical significance and hence derive maxwell's equations	U	PSO – 1, 2
CO-5	Able to explain phase space, microstate, microstate, ensemble and learn to distinguish different statistical distributions and judge which distribution applies to a given system	U, Ap	PSO – 1, 2
CO-6	Identify thermal properties of materials, inculcate experimental skills, and appraise the temperature dependent properties through experimentation.	U, Ap, An	PSO – 1, 2, 7

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: THERMODYNAMICS AND STATISTICAL MECHANICS

Credits: 3:0:1 (Lecture: Tutorial: Practical)

CO No.	CO	PO / PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Describe the fundamental laws of thermal Physics, Thermodynamics and Statistical Mechanics and interpret its significance.	PSO - 1	U, Ap	C	L	-
CO-2	Identify the thermal properties, applications of heat transfer, various thermodynamic processes and judge the efficiency of engines by comparing the performance of various vehicles	PSO-1,2	R, U, Ap	C	L	-

CO-3	Distinguish entropy and available energy in various thermodynamic processes and illustrate various phase transitions	PSO – 1, 2	U, Ap	C	L	-
CO-4	Describe thermodynamic variables, thermodynamic potentials, and its physical significance and hence derive maxwell's equations	PSO – 1, 2	U	C	L	-
CO-5	Able to explain phase space, microstate, microstate, ensemble and learn to distinguish different statistical distributions and judge which distribution applies to a given system	PSO – 1, 2	U, Ap	C	L	-
CO-6	Identify thermal properties of materials, inculcate experimental skills, and appraise the temperature dependent properties through experimentation.	PSO – 1, 2, 7	U, Ap, An	P		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO-1	3	-	-	-	-	-	-	1	1	-	2	-	2	-	-
CO-2	3	3	-	-	-	-	-	3	3	3	2	-	2	1	-
CO-3	3	3	-	-	-	-	-	3	3	2	1	-	1	1	-
CO-4	3	3	-	-	-	-	-	3	3	2	2	-	2	-	-
CO-5	3	3	-	-	-	-	-	3	3	1	2	-	2	-	-
CO-6	3	3	-	-	-	-	3	3	3	3	3	3	3	2	3

Correlation Levels:

Level	-	1	2	3
Correlation	Nil	Slightly / Low	Moderate / Medium	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics:

CO No	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO-1	✓	-	-	✓
CO-2	✓	-	✓	-
CO-3	✓	✓	-	✓
CO-4	✓	-	-	✓
CO-5	✓	-	-	✓
CO-6	✓	-	-	-

University of Kerala

Discipline	**PHYSICS**				
Course Code	**UK5DSEPHY301**				
Course Title	**TRANSISTOR AMPLIFIERS AND OSCILLATORS**				
Type of Course	**DSE**				
Semester	**V**				
Academic Level	**300 - 399**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 Hrs	-	-	4 Hrs
Pre-requisites					
Course Summary	To equip the student to understand the theory of different amplifier and oscillator circuits using transistors. It also gives an idea regarding different breakdown devices and FET.				

BOOKS FOR STUDY:

1. Basic Electronics Solid State: B. L. Theraja, S Chand & Company LTD.
2. Principles of Electronics, V K Mehta and Rohith Mehta, S Chand & Company LTD.
3. Electronic Devices and Circuit theory, Robert *Boylestad*

DETAILED SYLLABUS: THEORY

Module	Unit	Content	Hrs	CO No
I		**Large Signal Amplifiers (Book 1, Chapter 22)**	**12**	
	1	Power Amplification: Class A, Class B, Class C Operations	2	1
	2	Power rectangle and power efficiency	2	1

	3	Class B Push-Pull Amplifier Circuit	2	1,3
	4	Complementary Symmetry Push-Pull amplifier and crossover distortion	2	1,3
	5	Distortion in Amplifiers: linear and nonlinear distortions	3	1
	6	Noise and Noise Figure	1	1
II	**Sinusoidal Oscillators (Book 1, Chapter 28)**		**12**	
	7	Oscillator circuit and Barkhausen criterion for sustained oscillations,	1	1
	8	Tuned Base Oscillator	2	1,6
	9	Tuned Collector Oscillator	2	1,6
	10	Hartley Oscillator - Colpitt's Oscillator - Clapp Oscillator - Phase Shift Oscillator (derivations not required for all oscillators)	3	1,6
	11	Wien Bridge Oscillator.	2	1,6
	12	Crystal: piezoelectric effect, equivalent electric circuit, Q-factor, temperature coefficient - Crystal Controlled Oscillators	2	1,2
III	**Nonsinusoidal Oscillators (Book 1, Chapter 29)**		**12**	
	13	Nonsinusoidal Waveforms – mark-to-space ratio, pulse repetition time, pulse repetition frequency	2	1,6
	14	Classification of Nonsinusoidal Oscillators	2	1,6
	15	Multivibrators - Astable Multivibrator	2	6
	16	Monostable Multivibrator	2	6
	17	Bistable Multivibrator	2	6
	18	Schmitt Trigger	2	6
IV	**Field Effect Transistors (Book 1, Chapter 26)**		**12**	
	19	FET - JFET: Structure, Theory of Operation	3	2

	20	JFET Characteristics and JFET Parameters	3	5
	21	Common source JFET Amplifier	2	2
	22	MOSFET - DE MOSFET and E only MOSFET Working and Characteristics	4	2,5
V*	**Breakdown Devices (Book 1, Chapter 27)**		**12**	
	23	Unijunction Transistor (UJT)	2	4
	24	UJT Relaxation Oscillator	2	6
	25	Silicon Controlled Rectifier (SCR), 90^0 phase control of SCR	3	4
	26	Triac and Diac	3	4
	27	Silicon Controlled Switch	2	4

COURSE OUTCOMES

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the basics of Analog electronic functions.	U, R	**1**
CO-2	Analyse different solid-state devices	An	3
CO-3	Analyse transistor amplifier circuits	Ap, An	3
CO-4	Understand the working of breakdown devices	U	1
CO-5	Analyze the V-I characteristics of the circuits	E	2
CO-6	Describe oscillator circuits	U	1,2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: TRANSISTOR AMPLIFIERS AND OSCILLATORS

Credits: 4:0:0 (Lecture: Tutorial: Practical)

CO	CO	PO /	Cognitive	Knowledge	Lecture (L)/	Practical

No.		PSO	Level	Category	Tutorial (T)	(P)
CO-1	Understand the basics of Analog electronic functions.	PO 1/ PSO 1	U, R	F	L	
CO-2	Analyse different solid-state devices	PO 1/PSO 3	An	C	L	
CO-3	Analyse transistor amplifier circuits	PO2/ PSO 3	Ap, An	P	L	P
CO-4	Understand the working of breakdown devices	PO 1/ PSO 1	U	C	L	
CO-5	Analyze the V-I characteristics of the circuits	PO1 /PSO 2	E	P	L	P
CO-6	Describe oscillator circuits	PO1, 3/ PSO 1,2	U	C, P	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO-1	2	-	-	-	-	-	-	1	-	-	-	-	-	-	-
CO-2	-	-	2	-	-	-	-	1	-	-	-	-	-	-	-
CO-3	-	-	2	-	-	-	-	-	1	-	-	-	-	-	-
CO-4	2	-	-	-	-	-	-	1	-	-	-	-	-	-	-
CO-5	-	3	-	-	-	-	-	1	-	-	-	-	-	-	-
CO-6	3	3	-	-	-	-	-	1	-	1	-	-	-	-	-

Correlation Levels:

Level	-	1	2	3
Correlation	Nil	Slightly / Low	Moderate / Medium	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics:

CO No	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO-1	✓	✓	-	✓
CO-2	✓	-	-	✓
CO-3	✓	✓	-	✓
CO-4	✓	-	-	-
CO-5	✓	-	-	✓
CO-6	✓	✓	-	✓

University of Kerala

Discipline	**PHYSICS**				
Course Code	**UK5DSEPHY302**				
Course Title	**CHARACTERIZATION OF NANO MATERIALS**				
Type of Course	**DSE**				
Semester	**V**				
Academic Level	**300 - 399**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 Hrs	-	-	4 Hrs
Pre-requisites					
Course Summary	Structural Characterization, Microscopic and Morphological Analysis, Spectroscopy. Electrical, Mechanical, Magnetic, Thermal and Optical Properties of nanomaterials.				

BOOKS FOR STUDY:

1. Nanotechnology - Enabled Sensors, Kourosh Kalantar-zadeh and Benjamin Fry, Springer (2008).
2. Introduction to Nanoscience and Nanotechnology by Chattopadhyay, PHI, India
3. Handbook of Microscopy for Nanotechnology, Ed. By Nan Yao and Zhong Lin Wang, Kluwer Academic Press, (2005).
4. Nanostructures & Nanomaterials: Synthesis, Properties & Applications, Guozhong Gao, Imperial College Press, (2004).
5. Encyclopaedia of Materials Characterization, C. Richard Bundle, Charles A. Evans Jr., Shaun Wilson, Butterworth-Heinemann Publishers, (1992).
6. Nano chemistry, G. B. Sergeev, Elsevier, (2006).
7. Nanotechnology: Principles and Practices, Third Edition, by Sulabha K. Kulkarn (2014)

8. Cyclic Voltammetry Basic Principles, Theory & Setup(https://www.ossila.com/pages/cyclic-voltammetry) Written by Dr. Chris Bracher, Harry Robson and Dr. Max Reinhardt
9. Vibrating Sample Magnetometry, Brad Dodrill, Jeffrey R. Lindemuth,Pages 15-37.
10. The SQUID Handbook: Fundamentals and Technology of squids and SQUID Systems, I by Book Editor(s):Prof. Dr. John Clarke, Prof. Dr. Alex I. Braginski, (Chapter 2-SQUID Theory)
11. Thermal Analysis From Introductory Fundamentals to Advanced Applications, El-Zeiny Ebeid, Mohamed Barakat Zakaria, Paperback ISBN: 9780323901918, e-Book ISBN: 9780323901925 (1st Edition - June 23, 2021)
12. Dr. anchal srivastava, https://ebooks.inflibnet. ac.in/msp09/chapter/photoluminescence-pl-spectra/)
13. Superconducting quantum interference device (squid) aaron kraft, christoph rupprecht, yau-chuen yam, ubc physics 502 project (2017 fall)

BOOKS FOR REFERENCE:

1. Nanotechnology: Basic Science and Emerging Technologies – Mick Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmons, Burkhard Raguse, Overseas Press, (2005)
2. Nanocomposite Science and Technology, Pulickel M.Ajayan, Linda S.Schadler, Paul V. Braun,Wiley-VCH Verlag, Weinheim, (2003).
3. Introduction to Nanoscience, S. M. Lindsay, 1st Edition, Oxford University Press, (2010).

WEB REFERENCE

1. https://nptel.ac.in/courses/118/104/118104008/
2. https://nptel.ac.in/courses/113/107/113107081/
3. https://www.classcentral.com/course/swayam-structural-analysis-of-nanomaterials-14310

DETAILED SYLLABUS: THEORY

Module	Unit	Content	Hrs	CO No
I		**Structural Characterization (Book 1)**	**12**	
	1	X-ray diffraction (XRD) technique, Powder X-ray diffractometer	3	1,2
	2	Strain (W-H plot) and Particle size determination using Scherer formula, Applications of XRD.	5	1,2
	3	Infrared Spectroscopy and Raman Spectroscopy	4	1,2

II	**Microscopic and Morphological Analysis**		**12**	
	4	Introduction to Optical microscopy (Book 3)	1	4
	5	Field Emission Scanning Electron Microscopy (FESEM) and Energy Dispersive x-ray spectroscopy (EDS) (Book 2)	3	4
	6	Transmission Electron Microscopy (TEM) – Basic Instrumentation, SAED pattern, Bright Field and Dark field image analysis (Book 2)	3	4
	7	Scanning tunnelling microscope (STM) (Book 7)	3	4
	8	Brunauer – Emmer – Teller Surface area analysis (BET). (Book 5)	2	4
III	**Spectroscopy**		**12**	
	9	Photoelectron Spectroscopy (X-Ray Photoelectron Spectroscopy) (Book 7)	4	3
	10	Mass Spectroscopy – Secondary Ion Mass Spectroscopy (SIMS) –ICPMS (Book 5)	4	3
	11	Nuclear magnetic resonance (NMR) – Electron spin resonance (ESR). (Book 1)	4	3
IV	**Electrical, Mechanical and Magnetic Properties**		**12**	
	12	Electro analytical Techniques: Potentiometry – Cyclic Voltammetry (Book: 8)	4	4
	13	Vibrating sample magnetometer (Book:9)	4	4
	14	SQUID elementary ideas only (Book: 10, Chapter 2 & Book:13)	4	4
V*	**Thermal and Optical Properties (Book 11: Chapter 1)**		**12**	
	15	Differential scanning calorimeter (DSC) (Book 11)	3	4
	16	Thermogravimetric/Differential thermal analyzer (TG/DTA) (Book 11)	3	4
	17	Photoluminescence (PL) Emission and Excitation spectra (Book 12) Photoluminescence (PL) Spectra,	6	4

COURSE OUTCOMES

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	List and classify characterization techniques for structure of nanomaterials	R, U	PSO-1,2
CO-2	Classify and interpret different structural parameters of nanomaterials	U, Ap	PSO-3
CO-3	Analyse about different spectroscopic techniques to characterize nanomaterials	An	PSO-5,7
CO-4	Analyse and evaluate different instruments to quantify the properties of materials	An, E	PSO-3,7

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: CHARACTERIZATION OF NANO MATERIALS

Credits: 4:0:0 (Lecture: Tutorial: Practical)

CO No.	CO	PO / PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	List and classify characterization techniques for structure of nanomaterials	PO1,2, 3/ PSO-1,2	R, U	F, C	L	-
CO-2	Classify and interpret different structural parameters of nanomaterials	PO1,2,3/ PSO-3	U, Ap	F, C	L	-
CO-3	Analyse about different spectroscopic techniques to characterize nanomaterials	PO1,2,3,7 ,8/ PSO-5,7	An	F, C	L	-
CO-4	Analyse and evaluate different instruments to quantify the properties of materials	PO1,2,3,7 ,8/ PSO-3,7	An, E	F, C	L	-

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO-1	2	2	-	-	-	-	-	1	1	1	-	-	-	-	-
CO-2	-	-	3	-	-	-	-	2	2	2	-	-	-	-	-
CO-3	-	-	-	-	2	-	2	2	2	2	-	-	-	1	1
CO-4	-	-	2	-	-	-	3	2	2	2	-	-	-	1	1

Correlation Levels:

Level	-	1	2	3
Correlation	Nil	Slightly / Low	Moderate / Medium	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics:

CO No	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO-1	✓	-	-	✓
CO-2	-	-	-	✓
CO-3	-	-	-	✓
CO-4	✓	-		-

University of Kerala

Discipline	**PHYSICS**				
Course Code	**UK6DSCPHY300**				
Course Title	**ATOMIC AND MOLECULAR PHYSICS**				
Type of Course	**DSC**				
Semester	**VI**				
Academic Level	**300 - 399**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 Hrs	-	-	4 Hrs
Pre-requisites	1. Basic knowledge about atoms and molecules. 2. Basic knowledge about electromagnetic spectrum and quantum theory. 3. Basic ideas about Bohr model of atom and structure of hydrogen atom. 4. Basic ideas about influence of electric and magnetic fields on charges.				
Course Summary	The course has the following major objectives: The course introduces students to the basic physics of atoms, molecules, their spectra and the interaction of light with matter including the study of influence of electric and magnetic fields on atoms with the help of Zeeman and Stark effect. The students are expected to learn spin of electrons, space quantisation, and effect of nuclear motion on atomic spectra, Raman effect, NMR, ESR, rotational, vibrational and electronic spectra of diatomic molecules.				

BOOKS FOR STUDY:

1. G Aruldas: “Molecular structure and Spectroscopy” Prentice Hall of India ,2002.
2. 2. Modern Physics: R. Murugesan, S Chand & Co., Reprint, 2002
3. 3. Atomic Physics: J B Rajam, S Chand & Co.,1980.

4. 4. C N Banwell and E.M. McCash: "Fundamentals of Molecular Spectroscopy", Tata McGrow Hill.,1983.

BOOKS FOR REFERENCE:

1. Straughan and Walker (Eds): "Spectroscopy"- Vol. I and II (Chapman and Hall)
2. G.M. Barrow: "Introduction to molecular Spectroscopy", (McGraw Hill)
3. Modern Physics: G Aruldas and P Rajagopal, PHI, New Delhi, 2005.
4. Atomic Physics: Christopher J Foot, Oxford Master series in Physics,2005
5. J.M. Hollas, Modern Spectroscopy, Fourth Edition, John Wiley &Sons (2004)
6. Suresh Chandra, Molecular Spectroscopy, Narosa Publishing Co (2009)
7. H E White, Introduction to Atomic Spectroscopy McGraw-Hill Inc. 1st Edition. (1934).
8. D.N. Satyanarayana, Vibrational Spectroscopy-Theory and applications, New Age International Pvt Ltd (2004)
9. J.L. McHale, Molecular Spectroscopy, Pearson education Inc (2008).

DETAILED SYLLABUS: THEORY

Module	Unit	Content	Hrs	CO No
I		**Atomic Spectra & Atoms in External Fields (Book2 chapter 4 and Book3)**	**12**	
	1	Hydrogen atom spectrum	1	1
	2	Stern Gerlach experiment, Vector atom model	2	1
	3	Quantum states of electron in atoms	2	1
	4	Spin-orbit coupling (LS and JJ coupling schemes)	1	1
	5	Fine structure – Spectroscopic terms and selection rules	2	1
	6	Hyperfine structure	1	1
	7	Normal Zeeman effect	2	1
	8	Elementary Ideas of Anomalous Zeeman effect, Paschen Back effect and Stark effect	1	1
II		**Microwave & Infrared Spectroscopy (Book1 chapters 6 and 7 and Book4 chapters 2 and 3)**	**13**	
	9	Classification of molecules, Rotational spectra of diatomic molecules, Intensity of spectral lines, Effect of isotopic substitution	3	1,2

	10	The non-rigid rotor	1	1,2
	11	Rotational spectra of polyatomic molecules – Linear, symmetric top and asymmetric top molecules	2	1,2
	12	Microwave Oven	1	1,2
	13	Vibrational energy levels of diatomic molecules-harmonic oscillator and anharmonic oscillator (Morse Curve)	2	1,3
	14	IR spectra of vibrating diatomic molecule, selection rule	1	1,3
	15	Diatomic Vibrating rotator – selection rules, P, Q, R branches. Linear and symmetric top molecules	3	1,3
III	**Electronic Spectroscopy of Molecules (Book1 chapter 9 and Book4 chapter 6)**		**10**	
	16	Vibrational coarse structure: Progression and sequences	2	1
	17	The Franck-Condon principle	1	1
	18	Dissociation energy and dissociation products.	2	1
	19	Rotational fine structure of electronic vibration transitions	3	1
	20	Fortrat diagram, Pre-dissociation (elementary ideas)	2	1
IV	**Raman Spectroscopy (Book1 chapter 8 and Book4 chapter 4)**		**13**	
	21	Quantum and Classical theory of Raman effect	3	4
	22	Pure rotational Raman Spectrum –linear, Symmetric and Spherical top molecule	3	4
	23	Vibrational Raman Spectra, mutual exclusion principle	2	4
	24	Instrumentation and methods: Raman spectrometer	2	4
	25	Structure determination from Raman and IR spectroscopy	3	4
V*	**Resonance Spectroscopy (Book1 chapters 10 and 11 and Book4 chapter 7)**		**12**	
	26	NMR principle-Resonance condition	2	5
	27	NMR spectrometer	1	5
	28	Chemical shift-indirect spin-spin Interaction	1	5

	29	Applications of NMR spectroscopy- NMR Imaging and Interpretation of NMR Spectra	2	5
	30	ESR principle- Resonance condition	2	5
	31	ESR spectrometer	1	5
	32	Hyperfine interaction	1	5
	33	Applications of ESR spectroscopy-Study of Free Radicals and Structural Determination, Advantages of ESR Spectroscopy	2	5

COURSE OUTCOMES

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Identify and describe the rotational, vibrational and electronic energy states of various types of molecules and the interaction of electromagnetic radiation with molecules.	R, U	PSO-1,2
CO-2	Define and describe the microwave spectra of the molecule and compute various parameters	R, U, Ap	PSO-1,2
CO-3	Outline and explain the IR spectra of molecule and manipulate information about the molecule.	R, U, Ap	PSO-1, 2
CO-4	Describe, explain and construct molecular structure from combined analysis of Raman and IR spectra	R, U, Ap	PSO-1,2
CO-5	Recognise and infer the mechanism of spin resonances and interaction of electromagnetic radiations under resonance conditions of spin reorientation.	R, U	PSO-1,2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: ATOMIC AND MOLECULAR PHYSICS

Credits: 4:0:0 (Lecture: Tutorial: Practical)

CO No.	CO	PO / PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Identify and describe the rotational, vibrational and electronic energy states of various types of molecules and the interaction of electromagnetic radiation with molecules.	PO1,3,4, 5,6,8/ PSO-1,2	R, U	F, C	L	-
CO-2	Define and describe the microwave spectra of the molecule and compute various parameters	PO1,3,4, 5,6,8/ PSO-1,2	R, U, Ap	F, C	L	-
CO-3	Outline and explain the IR spectra of molecule and manipulate information about the molecule.	PO1,3,4, 5,6,8/ PSO-1,2	R, U, Ap	F, C	L	-
CO-4	Describe, explain and construct molecular structure from combined analysis of Raman and IR spectra	PO1,3,4, 5,6,8/ PSO-1,2	R, U, Ap	F, C	L	-

CO-5	Recognise and infer the mechanism of spin resonances and interaction of electromagnetic radiations under resonance conditions of spin reorientation.	PO1,3,4, 5,6,8/ PSO-1,2	R, U	F, C	L	-

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO-1	2	1	-	-	-	-	-	2	-	2	2	2	2	-	2
CO-2	2	2	-	-	-	-	-	2	-	3	2	2	3	-	2
CO-3	2	1	-	-	-	-	-	2	-	2	2	2	3	-	2
CO-4	2	1	-	-	-	-	-	3	-	2	2	2	2	-	3
CO-5	2	2	-	-	-	-	-	2	-	2	2	2	2	-	2

Correlation Levels:

Level	-	1	2	3
Correlation	Nil	Slightly / Low	Moderate / Medium	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics:

CO No	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO-1	✓	-	-	✓
CO-2	✓	✓	-	✓
CO-3	✓	✓	-	✓
CO-4	✓	✓	-	✓
CO-5	✓	-	-	-

University of Kerala

Discipline	**PHYSICS**				
Course Code	**UK6DSCPHY301**				
Course Title	**NUCLEAR AND PARTICLE PHYSICS**				
Type of Course	**DSC**				
Semester	**VI**				
Academic Level	**300 - 399**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 Hrs	-	-	4 Hrs
Pre-requisites	1. The student should have a fundamental understanding of atomic structure 2. The students must be familiar with the phenomenon of radioactivity 3. The students should have a basic understanding of fission and fusion reactions				
Course Summary	This course introduces the fundamental concepts of nuclear and particle physics. The first module comprises of the properties of nucleus and nuclear models. The nuclear decays and basics of radioactivity are discussed in the second module. The third module incorporates different types of nuclear reactions including fission and fusion, associated with nuclear science and technology as well as expanding the scope of application of radioactivity. The basics of particle physics, fundamental interactions and the dynamics of elementary particles under these forces are included in the fourth module. Fifth module explains the physical principles of various particle accelerators and detectors				

BOOKS FOR STUDY:

1. Concepts of Modern Physics: Arthur Beiser, Mc Graw Hills, Fifth Edition, 1995
2. Modern Physics – R Murugesan, S. Chand & Co., 2008
3. Nuclear Physics- D C Tayal, Himalaya Publication House, Fifth Edition, 2009
4. Modern Physics – G Aruldhas, PHI, 2018
5. Techniques for Nuclear and Particle Physics Experiments: A How-to Approach, Second Revised Edition, W. R. Leo, Springer-Verlag

BOOKS FOR REFERENCE:

1. Atomic and Nuclear Physics, N Subramaniam and Brijlal, S. Chand & Co.
2. Nuclear Physics, S N Ghoshal, S. Chand & Co.
3. Introduction to Elementary Particles, D Griffith, John Wiley & sons
4. Introductory Nuclear Physics, Kenneth S Krane, Wiley India Pvt. Ltd. 2008
5. Gaseous radiation detectors: Fundamentals and Applications, Fabio Sauli, Cambridge University Press.
6. The Quantum Frontier :The Large Hadron Collider :Don Lincoln, Johns Hopkins University Press,2009

WEB RESOURCES

1. https://nptel.ac.in/courses/115102017
2. https://www.space.com/large-hadron-collider-particle-accelerator (LHC)

DETAILED SYLLABUS: THEORY

Module	Unit	Content	Hrs	CO No
I		**Properties of Nuclei and Nuclear Models (Book:1 - Chapter: 11)**	**12**	
	1	Constituents of nucleus and their Intrinsic properties	2	1
	2	Binding energy, binding energy versus mass number curve, nuclear stability	2	1
	3	Nuclear forces- properties	1	1
	4	Meson theory	2	1
	5	Liquid drop model -semiempirical mass formula and significance of various terms	2	1

	6	Assumptions of Shell model-evidence for nuclear shell structure, nuclear magic numbers	2	1
	7	Collective model	1	1
II	**Radioactivity (Book: 1 - Chapter: 12; Book: 2 – Chapter: 34)**		**12**	
	8	Basics of radioactivity, properties of α, β and γ	1	2
	9	Law of radioactive disintegration, Half life, mean life	2	3
	10	Law of successive disintegration, Radioactive equilibrium (Transient, Secular)	2	3
	11	Basics of α-decay processes, theory of α-emission, α-ray spectrum, Geiger Nuttal law	3	2
	12	Beta decay- beta ray spectrum, Pauli's neutrino hypothesis, positron emission, electron capture	3	2
	13	Gamma decay, Gamma ray spectrum, internal conversion	1	2
III	**Nuclear Reactions (Book: 1 – Chapter: 12; Book: 2 - Chapter 34; Book: 4 – Chapter: 19)**		**12**	
	14	Types of Reactions, Conservation Laws	1	4
	15	Kinematics of reactions, Q-value- reaction rate- reaction cross section	2	4
	16	Reaction mechanism-Concept of direct reaction mechanism and compound nucleus.	2	4
	17	Nuclear fission-Bohr and Wheeler's theory	1	4
	18	Chain reaction -multiplication factor-critical size-atom bomb	2	4
	19	Nuclear fusion-sources of stellar energy, thermonuclear reactions-hydrogen bomb	2	4
	20	Controlled thermo-nuclear reactions, plasma confinement basics (magnetic bottle-Tokamak- inertial confinement).	2	4
IV	**Particle Physics (Book: 1 – Chapter: 13; Book: 3 - Chapter 18)**		**12**	
	21	Classification of elementary particles, basic features, Fundamental interactions	4	5

	22	Quantum numbers - Baryon number, Lepton number, Isospin, Hypercharge, Strangeness	2	5
	23	Symmetries and Conservation Laws	3	5
	24	Concept of quark model and standard model	3	5
V*	**Particle detectors and Accelerators (Book: 2 – Chapter: 29 & 30; Book: 4 – Chapter: 20; Book: 5 – Chapter: 2&9)**		**12**	
	25	Charged particle interaction with matter- Range, stopping power, The Bethe Bloch Formula (qualitative only)- Interaction of Radiation with matter	4	6
	26	Particle detectors - GM counter, scintillation counter, Resistive Plate Chambers	4	6
	27	Particle Accelerators - Linear accelerator, Cyclotron, Synchrotron, betatron	3	6
	28	Large Hadron Collider (Qualitative concepts only)*	1	6

COURSE OUTCOMES

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Identify nuclear constituents and general properties of nuclei and distinguish different nuclear models	U	PSO-1
CO-2	Describe the phenomenon of radioactivity	R, U	PSO-1
CO-3	Discuss and apply the basic idea of radioactivity for the mathematical formulation.	U, Ap	PSO-1,2
CO-4	Interpret different types of nuclear reactions, fission & fusion energies and applications	U, Ap	PSO-1,2
CO-5	Classify the elementary particles and relate their properties	U	PSO-1,2
CO-6	Delineate the application of different particle detectors and accelerators	Ap	PSO-1,2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: NUCLEAR AND PARTICLE PHYSICS

Credits: 4:0:0 (Lecture: Tutorial: Practical)

CO No.	CO	PO / PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Identify nuclear constituents and general properties of nuclei and distinguish different nuclear models	PO 1/ PSO 1	U	F, C	L	-
CO-2	Describe the phenomenon of radioactivity	PO 1/ PSO 1	R, U	F,C	L	-
CO-3	Discuss and apply the basic idea of radioactivity for the mathematical formulation.	PO 1,2/ PSO 1,2	U, Ap	C	L	-
CO-4	Interpret different types of nuclear reactions, fission & fusion energies and applications	PO 1/ PSO 1,2	U, Ap	F,C	L	-
CO-5	Classify the elementary particles and relate their properties	PO 1/ PSO 1,2	U	F, C	L	-
CO-6	Delineate the application of different particle detectors and accelerators	PO 1/ PSO 1,2	Ap	F, C	L	-

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO-1	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-
CO-2	2	-	-	-	-	-	-	2	-	-	-	-	-	-	-
CO-3	2	2	-	-	-	-	-	2	2	-	-	-	-	-	-
CO-4	2	2		-	-	-	-	2	-	-	-	-	-	-	-
CO-5	2	2	-	-	-	-	-	2	-	-	-	-	-	-	-
CO-6	2	2	-	-	-	-	-	2	-	-	-	-	-	-	-

Correlation Levels:

Level	-	1	2	3
Correlation	Nil	Slightly / Low	Moderate / Medium	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics:

CO No	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO-1	✓	-	-	✓
CO-2	✓	-	-	✓
CO-3	✓	-	-	✓
CO-4	✓	✓	-	✓
CO-5	✓	✓	-	✓
CO-6	✓	✓	-	-

University of Kerala

Discipline	**PHYSICS**				
Course Code	**UK6DSCPHY302**				
Course Title	**SOLID STATE PHYSICS**				
Type of Course	**DSC**				
Semester	**VI**				
Academic Level	**300 - 399**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 Hrs	-	-	4 Hrs
Pre-requisites	Basic ideas of quantum mechanics				
Course Summary	This course is designed to introduce the structure, electronic, and other fundamental properties of solids to the students. This course covers the detailed representation of crystal structure, symmetries in solid, x-ray diffraction, bonding, transport properties, electronic structure, vibration of the lattice, outline of magnetism, and superconductivity.				

BOOKS FOR STUDY:

1. Elements of Solid-State Physics, J. P Srivastava, Prentice Hall of India 2015 Fourth Edition
2. Elementary Solid-State Physics- Principles and Applications, M. Ali Omar, Pearson Education inc. 2011
3. Solid state Physics- Structure and properties of Materials, M. A Wahab, Narosa Publishing House Third Edition

BOOKS FOR REFERENCE:

1. Introduction to Solid State Physics: Charles Kittel, Wiley India Pvt. Ltd., 8 th Edn., 2004
2. Solid State Physics- S. O. Pillai, New Age international Publishers 10th Edition
3. Introduction to Solids: Leonid V. Azaroff, Tata Mc-Graw Hill, 2004

4. Solid State Physics: Neil W. Ashcroft and N. David Mermin, Cengage Learning, 1976
5. Solid State Physics: Rita John, McGraw Hill, 2014

DETAILED SYLLABUS: THEORY

Module	Unit	Content	Hrs	CO No
I		**Crystal Structure (Book 1)**	**12**	
	1	Basic Crystal Structure- Unit cell: primitive cell structures- Symmetry operations	2	1
	2	Crystal types- Indices of a lattice direction and a lattice plain- Crystal point groups and space groups	2	1
	3	Common crystal structures	1	1
	4	Reciprocal lattice- Bragg's law, Miller indices	2	1
	5	Laue's interpretation- Construction of a reciprocal lattice and applications	2	1
	6	X-ray diffraction Technique- Powder diffraction method.	1	1
	7	Electron and neutron diffraction techniques	2	1
II		**Free electron theory and Band theory of solids (Book 1)**	**12**	
	8	The Drude - Lorentz theory: Electrical, thermal conductivity and specific heat	2	2
	9	The Sommerfield model: Fermi surface and Fermi energy	3	2
	10	The electronic heat capacity- Wiedmann-Franz Law - Hall effect	2	2
	11	Bloch Theorem	1	2
	12	Kronig-Penney Model	3	2
	13	Brillouin Zones (Basic concepts only)	1	2
III		**Magnetic Properties of Materials (Book 2)**	**12**	
	14	Classification of magnetic materials-Origin of permanent magnetic moments	1	3
	15	Langevin's classical theory of diamagnetism	2	3

	16	Langevin's classical and quantum theory of paramagnetism	3	3
	17	Ferromagnetism- Temperature dependence of spontaneous magnetisation	2	3
	18	Ferromagnetic domains and Domain theory	2	3
	19	Antiferromagnetism-ferrimagnetism and ferrites (Basic concepts)	1	3
	20	Multiferroics and Giant Magnetic Resistance (Basic concepts only)	1	3
IV	**Superconductivity (Book 3)**		**12**	
	21	Superconductor- Properties, Critical Temperature	1	4
	22	Critical magnetic field- Meissner effect- Type I and Type II superconductors	2	4
	23	Origin of energy gap- Isotope effect	2	4
	24	London's Equations - London Penetration Depth-Coherence length	2	4. 5
	25	BCS theory	2	4,5
	26	dc and ac Josephson Effect	1	4,5
	27	High Temperature superconductivity, Metallic superconductors- Superconductivity in fullerenes- Applications of superconductivity (Basic concepts only)	2	4
V*	**Dielectric Properties of Materials (Book 3)**		**12**	
	28	Polarisation-Local electric field at an atom, Sources of polarizability	2	6
	29	Dielectric constant and its measurements, Electric susceptibility	2	6
	30	Polarizability- (Dipolar, Ionic and Electronic)- Clausius - Mossotti Equation	3	6
	31	Dipolar polarizability - Classical Theory	3	6
	32	Piezo, Pyro and ferro electric properties of crystals (Derivations not required)	1	6
	33	Ferroelectricity and ferroelectric domains-Qualitative ideas only	1	6

COURSE OUTCOMES

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Identify different crystal systems, reciprocal lattice and diffraction techniques.	U, Ap	1
CO-2	Understand the theories of electrical and thermal conduction	U, Ap	1,2
CO-3	Understand the magnetic properties of different materials	U, Ap	1, 3
CO-4	Understand the phenomena of superconductivity	R. Ap	1
CO-5	Discuss the theoretical formulations of superconductors and applications	U	1, 2
CO-6	Understand and evaluate dielectric properties of materials	U, Ap	1

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: SOLID STATE PHYSICS

Credits: 4:0:0 (Lecture: Tutorial: Practical)

CO No.	CO	PO / PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Identify different crystal systems, reciprocal lattice and diffraction techniques.	PO 1/ PSO 1	U, Ap	F, C	L	-
CO-2	Understand the theories of electrical and thermal conduction	PO 1/ PSO 1,2	U, Ap	F, C	L	-
CO-3	Understand the	PO 1/	U, Ap	C	L	-

	magnetic properties of different materials	PSO 1, 3				
CO-4	Understand the phenomena of superconductivity	PO 1/ PSO 1	R. Ap	F	L	-
CO-5	Discuss the theoretical formulations of superconductors and applications	PO 1/ PSO 1, 2	U	C	L	-
CO-6	Understand and evaluate dielectric properties of materials	PO 1/ PSO 1	U, Ap	C	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO-1	2	-	-	-	-	-	-	1	-	-	-	-	-	-	-
CO-2	2	1		-	-	-	-	1	-	-	-	-	-	-	-
CO-3	2	-	1	-	-	-	-	1	-	-	-	-	-	-	-
CO-4	2	-	-	-	-	-	-	1	-	-	-	-	-	-	-
CO-5	2	1	-	-	-	-	-	1	-	-	-	-	-	-	-
CO-6	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-

Correlation Levels:

Level	-	1	2	3
Correlation	Nil	Slightly / Low	Moderate / Medium	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics:

CO No	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO-1	✓	✓	-	✓
CO-2	✓	-	-	✓
CO-3	✓	✓	-	✓
CO-4	✓	-	-	✓
CO-5	✓	✓	-	✓
CO-6	✓	-	-	-

University of Kerala

Discipline	**PHYSICS**				
Course Code	**UK6DSEPHY301**				
Course Title	**OPERATIONAL AMPLIFIERS AND APPLICATIONS**				
Type of Course	**DSE**				
Semester	**VI**				
Academic Level	**300 - 399**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 Hrs	-	2 Hrs	5 Hrs
Pre-requisites					
Course Summary	This course aims to get a thorough knowledge of analog ICs. It also helps to understand instrumentation techniques and get an idea regarding transducers.				

BOOKS FOR STUDY:

1. Op Amps and Linear Integrated Circuits by Ramakant A Gayakwad
2. Principles of Electronics: V. K. Mehta and Rohit Mehta, S. Chand Ltd.,2020 Edition
3. Basic Electronics-Solid State: B. L. Theraja, S. Chand Ltd. 2005

BOOKS FOR REFERENCE:

1. Basic Electronics: Devices, circuits and IT fundamentals: Santiram Kal, PHI, 2010
2. Linear Integrated Circuits- D Roy Choudhury and Shail B Jain
3. Integrated Electronics by Jacob Millman& C Halkias (Tata McGraw Hill)

DETAILED SYLLABUS: THEORY

Module	Unit	Content	Hrs	CO No
I	**Operational Amplifiers (Book 2, Chapter 25)**		**9**	
	1	Emitter Coupled Differential amplifier, Block diagram of Op-Amp	1	1
	2	Concept of Virtual ground Characteristics of Op-Amp, Op-Amp parameters - Input resistance, Output resistance, Common Mode Rejection Ratio (CMMR), Slew rate, offset voltages	2	1
	3	Basic Op-Amp circuits - Inverting Op-Amp, Non-inverting Op-Amp	2	1,3
	4	Op-Amp as: Summing amplifier, Subtractor, Comparator, Voltage follower	2	1,3
	5	Integrator, and Differentiator	2	1,3
II	**Active Filters (Book 1, Chapter 8)**		**9**	
	6	Introduction, Active Filters (different types- qualitative idea only)	1	2
	7	First Order Low Pass Butterworth filter: filter design and frequency scaling	3	2
	8	First Order High Pass Butterworth filter	3	2
	9	Band-Pass Filter: Wide Band-Pass Filter	1	2
	10	Band Reject Filters: Wide Band-Reject Filter	1	2
III	**Op-amp oscillators (Book 1, Chapter 8)**		**9**	
	11	Oscillator types, frequency stability	1	3
	12	Phase Shift Oscillator	1	4
	13	Wien Bridge oscillator	1	4
	14	Quadrature Oscillator	1	4
	15	Square Wave Generator, Triangular Wave Generator (derivations not required)	3	4
	16	Sawtooth Wave Generator (derivations not required)	2	4

IV	**Specialised IC Applications (555 Timer) (Book 1, Chapter 10)**		**9**	
	17	The 555 Timer – block diagram	2	2
	18	The 555 Timer as a Monostable Multivibrator	1	2,4
	19	Monostable Multivibrator applications: frequency divider, pulse stretcher	2	4
	20	The 555 Timer as an Astable Multivibrator	2	4
	21	Astable multivibrator applications: square wave oscillator, free running ramp generator	2	4
V*	**Transducers and Instrumentation (Book 3, Chapter 36,37)**		**9**	
	22	Transducers and its Classification	1	5
	23	LVDT - Piezoelectric Transducer - Strain Gauge	2	5
	24	Temperature Transducers – Resistance Temperature Detectors - Thermistors - Thermocouples	2	5
	25	Various Types of Microphones- Loudspeaker	1	5
	26	Analog and Digital Instruments - Essentials of an Electronic Instrument - Multimeter	1	5
	27	Cathode Ray Oscilloscope - Cathode Ray Tube - Deflection Sensitivity of CRT, Digital Storage Oscilloscope (working principles only)	2	6

DETAILED SYLLABUS: PRACTICALS

Part A – At least 5 Experiments to be performed		**CO No**
Sl No	**Name of Experiment**	
1	FET characteristics: (i) To plot the static drain characteristics of FET (ii) To calculate the FET parameters (drain dynamic resistance, mutual conductance and amplification factor at a given operating point)	3
2	Hartley oscillator: To observe the output wave form and to measure the frequency of oscillations	3
3	Phase shift oscillator: (i) Trace the circuit (ii) To measure the frequency from the output waveform	4

4	OP Amp as Summing amplifier and Comparator (Zero crossing detector)	3
5	OP amp. - Inverting amplifier using IC 741 (i) Trace the circuit (ii) To construct an inverting amplifier using IC 741 and determine its voltage gain for different input voltages	3
6	OP amp. – Non-inverting amplifier using IC 741 (i) Trace the circuit (ii) To construct a Non-inverting amplifier using IC 741 and determine its voltage gain for different input voltage	3
7	Astable Multivibrator using IC 555- To design and set up an astable multivibrator using 555 timer for a frequency of 1 kHz	4
8	Monostable Multivibrator using IC 555 - To design a monostable multivibrator using 555 timer for 1 ms pulse width	4
9	First Order Low pass filter using IC 741	4
Part B* – At least One Experiment to be performed		
11	Operational Amplifier - Integrator	3
12	Operational Amplifier - Differentiator	3
13	First Order High pass filter using IC 741	3

C6OURSE OUTCOMES

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the concept of differential amplifier	U, R	1
CO-2	Describe the Op-Amp IC 741 and IC 555 Timer	U	1
CO-3	Apply the concepts of op-amp in electronic functions	Ap	2
CO-4	Construct waveform generators using IC 741 and IC 555 Timer	Ap	5
CO-5	Understand the basics of different transducers	U	1
CO-6	Apply the concepts of transducers in instrumentation	Ap	2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: OPERATIONAL AMPLIFIERS AND APPLICATIONS

Credits: 3:0:1 (Lecture: Tutorial: Practical)

CO No.	CO	PO / PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Understand the concept of differential amplifier	PO1/ PSO 1	U, R	F	L	
CO-2	Describe the Op-Amp IC 741 and IC 555 Timer	PO 1 /PSO 1	U	C	L	
CO-3	Apply the concepts of op-amp in electronic functions	PO 1/ PSO 2	Ap	C	L	P
CO-4	Construct waveform generators using IC 741 and IC 555 Timer	PO 1/ PSO 5	Ap	C,P	L	P
CO-5	Understand the basics of different transducers	PO 1/ PSO1	U	C, P	L	
CO-6	Apply the concepts of transducers in instrumentation	PO 1/ PSO 2	Ap	C	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO-1	2	-	-	-	-	-	-	2	-	-	-	-	-	-	-
CO-2	2	-	-	-	-	-	-	2	-	-	-	-	-	-	-
CO-3	-	2	-	-	-	-	-	2	-	-	-	-	-	-	-

CO-4	-	-	-		2	-	-	2	-	-	-	-	-	-	-
CO-5	2	-	-	-	-	-	-	2	-	-	-	-	-	-	-
CO-6	-	2	-	-	-	-	-	2	-	-	-	-	-	-	-

Correlation Levels:

Level	-	1	2	3
Correlation	Nil	Slightly / Low	Moderate / Medium	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics:

CO No	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO-1	✓	-	-	✓
CO-2	✓	✓	-	✓
CO-3	✓	-	-	✓
CO-4	✓	-	-	✓
CO-5	✓	-	-	-
CO-6	✓	-	-	-

University of Kerala

Discipline	**PHYSICS**				
Course Code	**UK6DSEPHY305**				
Course Title	**APPLIED OPTICS**				
Type of Course	**DSE**				
Semester	**VI**				
Academic Level	**300 - 399**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 Hrs	-	2 Hrs	5 Hrs
Pre-requisites	-				
Course Summary	The course on Applied Optics delves into advanced topics including holography for three-dimensional imaging, optical fibers for communication and sensing applications, nonlinear optics for manipulating light properties, optical sensors for detection and measurement purposes, and biophotonics for applications in biological and medical sciences. Students explore practical applications and theoretical principles underlying these optical technologies, gaining insights into their significance across various fields such as telecommunications, healthcare, and scientific research.				

BOOKS FOR STUDY:

1. Optics by Ajoy Ghatak 7th edition
2. Laser and Non-linear Optics by B B Laud
3. Introduction to Biophotonics by P N Prasad
4. Principles of nanophotonics by Motoichi Ohtsu , Kiyoshi Kobayashi, Tadashi Kawazoe, Takashi Yatsui
5. Nanophotonics by Paras N Prasad

BOOKS FOR REFERENCE:

1. Optics: Eugene Hecht, Addison-Wesley 2002
2. Nonlinear Optics by Robert W Boyd
3. Biophotonics: Concepts to Applications by Gerd Keiser
4. Introduction to Nanophotonics by Sergey V. Gaponenko

DETAILED SYLLABUS: THEORY

Module	Unit	Content	Hrs	CO No
I		**Holography**	**8**	
	1	Principle of holography, recording of holograms, reconstruction of images, theory, requirements, distinguishing characteristics of holograms.	4	1
	2	Different types of holograms, transmission and reflection types.	2	1
	3	Applications of holography	2	1
II		**Optical fibers**	**9**	
	4	Introduction, total internal reflection, optical fibre, step index fibre, Graded index fibre, Coherent bundle, the numerical aperture	3	2
	5	Attenuation in optical fibre, single mode fibre, multimode fibre, power law profile	2	2
	6	Pulse dispersion in multimode fibre: Ray Dispersion in Multimode Step Index Fibers, Material Dispersion.	2	2
	7	Fibre sensors (qualitative), fibre optic communication (qualitative), Advantages of fibre optic communication system.	2	2
III		**Non-linear Optics**	**9**	
	8	Harmonic generation- second harmonic generation- phase matching, third harmonic generation	4	3
	9	Optical mixing, parametric generation of light, self-focusing of light	2	3

	10	Multiquantum photoelectric effect, two photon processes and theory of two photon processes	2	3
	11	Multiphoton processes- three photon processes, second harmonic generation	1	3
IV	**Bio photonics**		**10**	
	12	Photobiology—At the Core of Biophotonics, Interaction of Light with Cells, Light Absorption in Cells, Light-Induced Cellular Processes, Photochemistry Induced by Exogenous Photosensitizers.	3	4
	13	Interaction of Light with Tissues, Photoprocesses in Biopolymers- The Human Eye and Vision, Photosynthesis	3	4
	14	In Vivo Photoexcitation, Free-Space Propagation, Optical Fiber Delivery System, Articulated Arm Delivery, Hollow Tube Waveguides	2	4
	15	In Vivo Spectroscopy, Optical Biopsy, Single-Molecule Detection	2	4
V*	**Nano photonics**		**9**	
	16	Introduction to nanophotonics-breaking through diffraction limit, evanescent waves, nanophotonics and its true nature	2	5
	17	Foundations of nanophotonics: photons and electrons; similarities and differences, free space propagation, confinement of photons and electrons, propagation through classically forbidden zone: tunnelling.	2	5
	18	Localization under a periodic potential: band gap, Cooperative effects for photons and electrons.	2	5
	19	Nanoscale optical interactions, nanoscale confinement of electronic interactions; nanoscale electronic energy transfer, Near field interaction and microscopy, nanoscale enhancement of optical interactions.	3	5

DETAILED SYLLABUS: PRACTICALS

Part A – At least 5 Experiments to be performed		**CO No**
Sl No	**Name of Experiment**	
1	Optical fibre characteristics – numerical aperture of an optical fiber	6
2	Attenuation in Optical fiber	6
3	Bandwidth of given optical fiber	6
4	Fiber optic testing (i) fiber continuity test using light source and power meter (ii) cable loss test	6
5	Characteristics light detectors (i) Photodiode (ii) LDR	6
6	Study of photoelectric effect and determination of of Planck's constant	6
Part B* – At least One Experiment to be performed		
7	Bio photonics box experiments: Light penetration, Fluorescence, Sunscreen, Light scattering and propagation	6
8	Recording and reconstruction of a transmission hologram	6

COURSE OUTCOMES

No.	**Upon completion of the course the graduate will be able to**	**Cognitive Level**	**PSO addressed**
CO-1	Explain the process of holographic imaging and the principles behind the formation of three-dimensional images from holographic recordings.	U	PSO-1,2,3,5,6
CO-2	Explain the basic principles of optical fiber, propagation of light through optical fiber, attenuation in optical fiber and applications of optical fibers	U, Ap	PSO-1,2,3,5,6
CO-3	Explain the mechanism behind non-linear optical phenomena such as harmonic generations, optical mixing, multiphoton process etc.	R, U	PSO-1,2,3,5

CO-4	Explain the fundamental concepts of bio photonics, such as light tissue interactions and the principles of biophotonic imaging technique.	U	PSO-1,2,3,5
CO-5	Explain the basic principles of light matter interactions in the nanoscale.	R, U	PSO-1,2,3,5
CO-6	Apply theoretical knowledge in designing, conducting, and interpreting experiments in applied optics to solve real-world problems effectively.	U, Ap, An	PSO-1,2,3,5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: APPLIED OPTICS

Credits: 3:0:1 (Lecture: Tutorial: Practical)

CO No.	**CO**	**PO / PSO**	**Cognitive Level**	**Knowledge Category**	**Lecture (L)/ Tutorial (T)**	**Practical (P)**
CO-1	Explain the process of holographic imaging and the principles behind the formation of three-dimensional images from holographic recordings.	PSO-1,2,3,5,6 PO-1,2	U	F, C	L	-
CO-2	Explain the basic principles of optical fiber, propagation of light through optical fiber, attenuation in optical fiber and applications of optical fibers	PSO-1,2,3,5,6 PO-1,2	U, Ap	F, C	L	-

CO-3	Explain the mechanism behind non-linear optical phenomena such as harmonic generations, optical mixing, multiphoton process etc.	PSO-1,2,3,5 PO-1,2	R, U	F, C	L	-
CO-4	Explain the fundamental concepts of bio photonics, such as light tissue interactions and the principles of biophotonic imaging technique.	PSO-1,2,3,5 PO-1,2	U	F, C	L	-
CO-5	Explain the basic principles of light matter interactions in the nanoscale.	PSO-1,2,3,5 PO-1,2	R, U	F, C	L	-
CO-6	Apply theoretical knowledge in designing, conducting, and interpreting experiments in applied optics to solve real-world problems effectively.	PSO-1,2,3,5 PO-1,2	U, Ap, An	F, C	-	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO-1	2	2	2	-	2	1		3	2	-	-	-	-		
CO-2	2	2	2	-	2	-		3	2	-	-	-	-		
CO-3	3	2	2	-	1	-		3	2	-	-	-	-		
CO-4	3	2	2	-	1	-		3	2	-	-	-	-		
CO-5	3	2	2	-	1	-		3	2	-	-	-	-		
CO-6	1	2	1	-	2	-		3	2	-	-	-	-		

Correlation Levels:

Level	-	1	2	3
Correlation	Nil	Slightly / Low	Moderate / Medium	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

CO No	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO-1	✓	-	-	✓
CO-2	✓	-	-	✓
CO-3	✓	-	-	✓
CO-4	✓	✓	-	✓
CO-5	✓	✓	-	-
CO-6	✓	-	-	-

University of Kerala

Discipline	**PHYSICS**				
Course Code	**UK7DSCPHY400**				
Course Title	**ADVANCED MATHEMATICAL PHYSICS**				
Type of Course	**DSC**				
Semester	**VII**				
Academic Level	**400 - 499**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 Hrs	-	-	4 Hrs
Pre-requisites	Need an understanding of vectors, Fourier series, Complex numbers, Partial and Ordinary differential equations.				
Course Summary	By the end of the course, students will have developed advanced mathematical skills and a solid foundation in the mathematical techniques essential for tackling complex problems in theoretical and applied Physics. They will be well-equipped to pursue further studies or research in areas such as quantum field theory, general relativity, condensed matter physics, and mathematical physics.				

BOOKS FOR STUDY:

1. G.B. Arfken and H.J. Weber, Mathematical methods for Physcisits,6th Edition, Elsevier, 2005.
2. C. Harper, Introduction to Mathematical Physics, Prentice Hall ,1986.
3. B.S. Rajput, Mathematical Physics, 16th edition, Pragati Prakashan, 2003.
4. Daniel Fleisch, A Student's guide to Vectors and Tensors, Ist Edition, Cambridge University Press, 2012.
5. A.W. Joshi, Matrices and Tensors in Physics,3rd Edition, New Age International Pub, 2003.

BOOKS FOR REFERENCE:

1. Complex Variables and Applications, J.W. Brown& R.V. Churchill, 7th Ed. 2003, Tata McGraw-Hill
2. Differential Equations, George F. Simmons, 2006, Tata McGraw-Hill.
3. W.W. Bell, Special Functions for Scientists and Engineers, Dover Publications (2004)
4. H.K. Dass and R. Verma, Mathematical Physics, S. Chand & Co Pvt Ltd (1997)
5. B.D. Gupta, Mathematical Physics, 4th Edition, Vikas Publishing House (2004)
6. Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press
7. Mathematics for Physicists, P. Dennery and A. Krzywicki, 1967, Dover Publications.

DETAILED SYLLABUS: THEORY

Module	Unit	Content	Hrs	CO No
I		**Complex Analysis**	**10**	
	1	Cauchy's integral theorem and Formula	3	1
	2	Taylor expansion and Laurent series, zeroes and singularities	2	1
	3	Cauchy's residue theorem, Poles	3	1
	4	Evaluation of definite Integrals.	2	1
II		**Differential equations and Special Functions**	**16**	
	5	Second Order linear ODEs- singular points	1	2
	6	Series solution- Frobenius method and its applications to differential equations	2	2
	7	Legendre, Bessel (first and second kind), Hermite and Laguerre Differential Equations	6	2
	8	Properties -Rodrigues Formula (Derivations not needed), Generating Function	4	2
	9	Orthogonality and recurrence relations of Legendre, Bessel, Hermite and Laguerre.	3	2
III		**Integrals Transforms**	**16**	
	10	Fourier Transforms- Fourier Integral theorem	1	3
	11	Fourier sine and cosine transform	1	3

	12	Examples: Fourier transform of single pulse, trigonometric, exponential and Gaussian Functions.	2	3
	13	Inverse Fourier transform and Convolution theorem	2	3
	14	Properties of Fourier transforms (translation, change of scale, complex conjugation, One dimensional Wave Equations	2	3
	15	Laplace Transform (LT) of Elementary functions.	1	3
	16	Properties of LTs: Change of Scale Theorem, Shifting Theorem	1	3
	17	LTs of Derivatives and Integrals of Functions	2	3
	18	Derivatives and Integrals of LTs	1	3
	19	LT of Unit Step function, Periodic Functions	1	3
	20	Convolution Theorem and Inverse LT	2	3
IV	**Some Special Integrals**		**06**	
	21	Gamma Functions, Expression of Integrals in terms of Gamma Functions	2	4
	22	Dirac delta function and properties, Laplace and Fourier transform of Dirac delta function.	2	4
	23	Green Function and general properties.	2	4
V*	**Tensor Analysis**		**12**	
	24	Coordinate transformation, Contravariant and mixed tensors	2	5
	25	Addition, Subtraction, Outer product, Inner product and Contraction	2	5
	26	Symmetric and antisymmetric tensors. Quotient law	1	5
	27	Metric tensor, Raising and lowering of indices	1	5
	28	Tensor derivatives, The Christoffel symbols and their transformation laws	2	5
	29	Covariant derivative of tensors	1	5
	30	Equation of Geodesic	1	5
	31	Riemannian curvature tensor	2	5

COURSE OUTCOMES

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Develop a strong foundation in complex analysis and apply its applications in Physics.	Ap, An	1,2,7
CO-2	Able to solve second-order linear ODEs with singular points, applying series solutions using the Frobenius method, and understanding the properties and applications of special functions such as Legendre, Bessel, Hermite, and Laguerre functions.	Ap.An	1,2,7
CO-3	Acquired skills to solve complex problems involving differential equations and system analysis using transform techniques.	U,Ap	1,2,7
CO-4	Understand and apply Gamma function, Green function and Dirac Delta function to express integrals, analyse distributions and solve differential equations.	U,Ap	1,2,7
CO-5	Understanding basic tensor operations, using tensor notation, and Apply of tensor calculus in studying physical systems.	U, Ap	1,2,7

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: ADVANCED MATHEMATICAL PHYSICS

Credits: 4:0:0 (Lecture: Tutorial: Practical)

CO No.	CO	PO / PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Develop a strong foundation in complex analysis and its applications in Physics.	PO 1,2/ PSO 1,2,7	Ap, An	C,P	L	-

CO-2	Able to solve second-order linear ODEs with singular points, applying series solutions using the Frobenius method, and understanding the properties and applications of special functions such as Legendre, Bessel, Hermite, and Laguerre functions.	PO 1,2/ PSO 1,2,7	Ap.An	C,P	L	-
CO-3	Acquired skills to solve complex problems involving differential equations and system analysis using transform techniques.	PO 1,2/ PSO 1,2,7	U,Ap	C,P	L	-
CO-4	Understand and apply Gamma function, Green function and Dirac Delta function to express integrals, analyse distributions and solve differential equations.	PO 1,2,6/ PSO 1,2,7	U,Ap	F,C,P	L	-
CO-5	Understanding basic tensor operations, using tensor notation, and Apply of tensor calculus in studying physical systems.	PO 1,2,6/ PSO 1,2,7	U, Ap	F,C,P	L	-

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO-1	3	3	-	-	-	-	3	3	3	-	-	-	-	-	-
CO-2	3	3	-	-	-	-	3	3	3	-	-	-	-	-	-
CO-3	3	3	-	-	-	-	3	3	3	-	-	-	-	-	-
CO-4	3	3	-	-	-	-	3	3	3	-	-	-	3	-	-
CO-5	3	3	-	-	-	-	3	3	3	-	-	-	3	-	-

Correlation Levels:

Level	-	1	2	3
Correlation	Nil	Slightly / Low	Moderate / Medium	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics:

CO No	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO-1	✓	✓	-	✓
CO-2	✓	✓	-	✓
CO-3	✓	✓	-	✓
CO-4	✓	✓	-	✓
CO-5	✓	✓	-	-

University of Kerala

Discipline	**PHYSICS**				
Course Code	**UK7DSCPHY401**				
Course Title	**QUANTTUM MECHANICS – II**				
Type of Course	**DSC**				
Semester	**VII**				
Academic Level	**400 - 499**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 Hrs	-	-	4 Hrs
Pre-requisites	Inadequacy of classical theory, Basic quantum mechanics, Schrodinger equation, One dimensional problem-solutions				
Course Summary	This course aims to provide a strong foundation to the principles of quantum mechanics and equip the students to apply these principles to solve advanced quantum mechanical problems				

BOOKS FOR STUDY:

1. Introduction to quantum mechanics : David, J Griffith, Prentice Hall, Second Edition
2. Quantum Mechanics : B H Bransden and C J Joachain, Pearson Education Ltd
3. Quantum Mechanics : G Aruldhas, PHI, 2nd Edition, 2020

BOOKS FOR REFERENCE:

1. A text book of Quantum Mechanics- P M Mathews & Venkitesan, Tata Mc Graw Hill, 2010
2. Quantum Mechanics Theory and Applications-Ajoy Ghatak, S Lokanathan , 5th Edn
3. Quantum Mechanics-Leonard I Schiff ,3rd Edn
4. Quantum Mechanics-V K Thankappan , 5th Edn
5. Quantum Mechanics: Concepts and Applications- Nouredine Zettili, Second Edition,Wiley.

DETAILED SYLLABUS: THEORY

Module	Unit	Content	Hrs	CO No
I		**SYMMETRIES AND CONSERVATION LAWS**	**11**	
	1	Unitary transformation: Definition and properties, Infinitesimal and finite unitary transformation	3	1,2
	2	Generator of infinitesimal and finite translation, Conservation of linear momentum	3	1
	3	Generator of infinitesimal and finite rotation, Conservation of angular momentum	3	1
	4	Time evolution operator	2	1
II		**MATRIX REPRENSENTATION AND PICTURES**	**11**	
	5	Matrix representation of operators and wave functions	2	2
	6	Simple Harmonic Oscillator: Operator form	3	2,4
	7	Matrix representation of Hamiltonian, Number operator, raising and lowering operators	3	2
	8	Pictures: Schrodinger picture, Heisenberg picture and interaction picture	3	2
III		**ANGULAR MOMENTUM**	**20**	
	9	Orbital angular momentum operators and commutation relations	2	3
	10	Eigen values and eigen functions of L^2 and Lz	4	2,3
	11	General angular momentum-eigen values of J^2 and Jz-	4	2,3
	12	Matrix representation of angular momentum operators	3	2,3
	13	Spin angular momentum –spin vectors for a spin ½ system	3	3
	14	Addition of angular momentum- Clebsch-Gordan coefficients.	4	3
IV		**THREE-DIMENSIONAL ENERGY EIGENVALUE PROBLEMS**	**6**	
	15	Particle in spherical symmetric potential-general solution	2	4
	16	Rigid rotator	1	2,4

	17	Hydrogen atom problem	3	4
V*	**RELATIVISTIC WAVE EQUATIONS**		**12**	
	18	Klein Gordon Equation, interpretation and equation of continuity	2	5
	19	Dirac Equation: Dirac matrices	2	5
	20	Probability current density and equation of continuity	2	5,2
	21	Covariant form of Dirac equation	1	5
	22	Plane wave solution of Dirac equation	3	5
	23	Negative energy states, Spin of Dirac particle	2	5

COURSE OUTCOMES

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Identify the quantum mechanical concepts of symmetry operations and associated conservation laws	U, Ap	PSO-1,2
CO-2	Identify the concepts of matrix representation of operators and wave functions and apply these concepts to solve quantum mechanical problem	U, Ap	PSO-1,2
CO-3	Recognize the concepts related to angular momentum operators, their eigen values, eigen functions, commutation relations and matrix representation	U, Ap	PSO-1, 2
CO-4	Apply problem solving techniques in quantum mechanics to three dimensional problems	U, Ap	PSO-1, 2, 3
CO-5	Compare the physical concepts of Klein Gordon equation and Dirac relativistic equation	U, Ap	PSO-1,2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: QUANTTUM MECHANICS – II

Credits: 4:0:0 (Lecture: Tutorial: Practical)

CO No.	CO	PO / PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Identify the quantum mechanical concepts of symmetry operations and associated conservation laws	PO1,3,4, 5,6,8/ PSO-1,2	U, Ap	F, C	L	-
CO-2	Identify the concepts of matrix representation of operators and wave functions and apply these concepts to solve quantum mechanical problem	PO1,3,4, 5,6,8/ PSO-1,2	U, Ap	F, C	L	-
CO-3	Recognize the concepts related to angular momentum operators, their eigen values, eigen functions, commutation relations and matrix representation	PO1,3,4, 5,6,8/ PSO-1, 2	U, Ap	F, C	L	-
CO-4	Apply problem solving techniques in quantum mechanics to three dimensional problems	PO1,3,4, 5,6,8/ PSO-1, 2	U, Ap	F, C	L	-
CO-5	Compare the physical concepts of Klein Gordon equation and Dirac relativistic equation	PO1,3,4, 5,6,8/ PSO-1,2	U, Ap	F, C	L	-

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO-1	3	2	-	-	-	-	-	2	-	2	2	2	2	-	3
CO-2	3	2	-	-	-	-	-	2	-	2	2	2	2	-	2
CO-3	3	2	-	-	-	-	-	3	-	2	2	2	3	-	3
CO-4	3	2	2	-	-	-	-	2	-	3	3	2	2	-	2
CO-5	3	2	-	-	-	-	-	2	-	2	2	2	2	-	2

Correlation Levels:

Level	-	1	2	3
Correlation	Nil	Slightly / Low	Moderate / Medium	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics:

CO No	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO-1	✓	✓	-	✓
CO-2	✓	✓	-	✓
CO-3	✓	✓	-	✓
CO-4	✓	-	-	✓
CO-5	✓	-	-	-

University of Kerala

Discipline	**PHYSICS**				
Course Code	**UK7DSEPHY401**				
Course Title	**ENVIRONMENTAL SUSTAINABILITY OF NANOMATERIALS**				
Type of Course	**DSE**				
Semester	**VII**				
Academic Level	**400 - 499**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 Hrs	-	-	4 Hrs
Pre-requisites	-				
Course Summary	Knowledge about Photocatalysis for Environmental Remediation, Understanding Photocatalysis and Photocatalyst, Water Splitting for Hydrogen Production, Nanotechnology for Carbon Dioxide Capture and Conversion, Circular Economy for Waste Reduction and Carbon Footprint.				

BOOKS FOR STUDY:

1. Photocatalysis and Water Purification - From Fundamentals to Recent Applications, Pierre Pichat (Editor), Wiley-VCH Verlag GmbH &Co. K Ga A, Boschstr. 12, 69469 Weinheim, Germany 2013.
2. Testing Novel Water Oxidation Catalysts for Solar Fuels Production, Ed. By Carminna Ottone, Simelys Hernández, Marco Armandi, Barbara Bonelii, Springer, 2019.
3. Nanomaterials and Direct Air Capture of CO2, Dirk Fransaer, Nanotechnology for Energy Sustainability, Ed. Marcel Van de Voorde, Wiley VCH, 2017.
4. Green Carbon Dioxide: Advances in CO2 Utilization - Gabriele Centi, Siglinda Perathoner ISBN: 978-1- 118-59088-1 March 2014.
5. Waste Valorisation: Waste Streams in a circular economy - Carol Sze Ki Lin, Guneet Kaur, Chong Li, Xiaofeng Yang, Christian V. Stevens, Wiley, ISBN: 978-1-119-50270-8; 2020.

BOOKS FOR REFERENCE:

1. Sustainable Bioconversion of Waste to Value Added Products - Inamuddin, Anish Khan, Springer Cha, ISBN978-3-030-61839-1; 2021.
2. Nanomaterials for Environmental Protection, Ed. By Boris I. Kharisov, Oxana V. Kharissova, H. V. Rasikha Dias, John Wiley, 2015.
3. Nanotechnologies for Environmental Remediation : Applications and Implications, edited by Giusy Lofrano, Giovanni Libralato, Jeanette Brown, Springer, 2016.
4. Hydrogen Production by Electrolysis, Edited by AgataGodula –Jopek, Wiley – VCH, 2015.
5. Environmental Applications of Nanomaterials: Synthesis, Sorbents and Sensors By Glen E. Fryxell, Guozhong Cao, Imperial Collge Press, 2007.

WEB REFERENCES

1. https://nptel.ac.in/content/storage2/courses/105108075/module9/Lecture40.pdf
2. https://nptel.ac.in/courses/118/107/118107015/
3. https://nptel.ac.in/courses/105/107/105107181/

DETAILED SYLLABUS: THEORY

Module	Unit	Content	Hrs	CO No
I		**Photocatalysis for Environmental Remediation (Book1: Chapter 1&2)**	**12**	
	1	Introduction – Definition – type of photocatalysis	2	1
	2	TiO2 based photocatalytic reactions - Key Species in		
	3	Photocatalytic Reactions -	3	1
	4	Trapped Electron and Hole - Superoxide Radical and Hydrogen Peroxide - Hydroxyl Radical (OH•) - Singlet Molecular Oxygen	3	1
II		**Understanding Photocatalysis and Photocatalyts (Book 1: Chapter 3)**	**12**	
	5	Photocatalytic rate -Kinetic models	2	2
	6	Thermodynamic Aspect of Photocatalysis - Design of Active Photocatalysts –	2	2
	7	A Conventional Kinetics in Photocatalysis: First-Order Kinetics Langmuir–Hinshelwood Mechanism	3	2
	8	Problems Related to Particle Size of Photocatalysts -	2	2

	9	Recombination of a Photoexcited Electron and a Positive Hole - Electron Traps as a Recombination Centre.	3	2
III	**Water Splitting for Hydrogen Production (Book 2: Chapter 1 and 5)**			
	10	General – The water splitting reaction – Natural water splitting	2	3
	11	Water oxidation catalysts – Semiconductors for water splitting	4	3
	12	Electrochemical measurement as screening method for water oxidation	3	3
	13	Preparation of active electrodes – wet method – dry method – Assessment of electrocatalytic activity.	3	3
IV	**Nanotechnology for Carbon Dioxide Capture and Conversion (Book 3: Chapter 46)**		**12**	
	14	Introduction – CO2 as a resource – Circular CO2 economy	2	4
	15	CO2 capture/Separation technologies – Direct air capture and nanomaterials.	3	4
	15	Nanomaterials – Metal Organic Frame (MOF)		
	16	Gas separation	3	4
	17	Carbon Nanotubes (CNTs) Nanoporous membranes –	2	4
V*	**Circular Economy for Waste Reduction and Carbon Footprint**		**12**	
	18	Carbon's critical role as life essential element and in non-renewable fuels and chemicals.	3	5
	19	Various sources of carbon waste eg., industrial emissions, biomass residue, manure, garbage which are of environmental concern.	4	5
	20	Integration of Circular economy and Sustainable Development.	3	5
	21	Possible supply chain scenarios for conversion of waste carbon to valuable products.	2	5

COURSE OUTCOMES

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Explain the role of nanotechnology for sustainable energy and conversion of energy directly or indirectly and describe nanoscale catalysts used to enhance the production rate.	U	PSO-1,2
CO-2	Discuss and analyse synthesis and characterisation of nanomaterials for photocatalysis	U, An	PSO-2,3,4
CO-3	Cite the various methods for hydrogen production and summarise knowledge about photochemical and photocatalysts and analyse techniques used to hydrogen storage.	R, U, An	PSO-3,5,6
CO-4	Describe, demonstrate and analyse CO2 capturing and circular economy for sustainable development.	U, Ap, An	PSO-2,3,5,6,7
CO-5	Analyse and appraise and integrate circular economy for sustainable development.	An, E	PSO-4,5,6,7

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: ENVIRONMENTAL SUSTAINABILITY OF NANOMATERIALS

Credits: 4:0:0 (Lecture: Tutorial: Practical)

CO No.	CO	PO / PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Explain the role of nanotechnology for sustainable energy and conversion of energy directly or indirectly and describe nanoscale	PO1.3.4. 5.6.8 / PSO1,2	U	F, C	L	-

	catalysts used to enhance the production rate.					
CO-2	Discuss and analyse synthesis and characterisation of nanomaterials for photocatalysis	PO1,2,3, 4,5,6,8 / PSO 2,3,4	U, An	F, C	L	-
CO-3	Cite the various methods for hydrogen production and summarise knowledge about photochemical and photocatalysts and analyse techniques used to hydrogen storage.	PO1,2,3, 4,7 / PSO 3,5,6	R, U, An	F, C, P	L	-
CO-4	Describe, demonstrate and analyse CO2 capturing and circular economy for sustainable development.	PO1,2,3, 4,5,7,8 / PSO 2,3,5,6,7	U	F, C	L	-
CO-5	Analyse and appraise and integrate circular economy for sustainable development.	PO1,2,3, 4,5,6,7,8 / PSO4,5,6 ,7	U, An	F, C	L	-

CO-6	Explain the role of nanotechnology for sustainable energy and conversion of energy directly or indirectly and describe nanoscale catalysts used to enhance the production rate.	PO1.3.4. 5.6.8 / PSO 1,2	R, U, An	F, C, P	L	-

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO-1	2	2	-	-	-	-	-	2	2	-	-	-	-	-	2
CO-2	-	2	2	1	-	-	-	-	2	2	1	-	-	-	-
CO-3	-	-	2	-	2	2	-	-	-	2	-	2	2	-	-
CO-4	-	1	2	-	2	2	2	-	1	2	-	2	2	2	-
CO-5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Correlation Levels:

Level	-	1	2	3
Correlation	Nil	Slightly / Low	Moderate / Medium	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

CO No	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO-1	✓	-	-	✓
CO-2	✓	-	-	✓
CO-3	-	✓	-	✓
CO-4	-	✓	-	✓
CO-5	✓	-	-	-
CO-6	✓	-	-	-