

Department of Physics

B.Sc. (Hons.) Physics Curriculum and Syllabus

(Applicable to the students admitted from AY: 2023 onwards)



**School of Engineering and Sciences
SRM University AP, Andhra Pradesh**

Category Wise Credit Distribution			
Course Sub-Category	Sub-Category Credits	Category Credits	Learning Hours
Ability Enhancement Courses (AEC)		8	240
University AEC	4		
School AEC	4		
Value Added Courses (VAC)		8	240
University VAC	8		
School VAC	0		
Skill Enhancement Courses (SEC)		15	450
School SEC	7		
Department SEC	2		
SEC Elective	6		
Foundation/ Interdisciplinary courses (FIC)		17	510
School FIC	17		
Department FIC	0		
Core + Core Elective including Specialization (CC)		80	2400
Core	68		
Core Elective (Inc Specialization)	12		
Minor (MC) + Open Elective (OE)	15	15	
Research / Design / Internship/ Project (RDIP)		17	510
Internship / Design Project / Startup / NGO	5		
Internship / Research / Thesis	12		
Total		160	4800

Semester wise Course Credit Distribution Under Various Categories										
Category	Semester								Total	%
	I	II	III	IV	V	VI	VII	VIII		
Ability Enhancement Courses - AEC	2	2	2	2	0	0	0	0	8	5
Value Added Courses - VAC	2	2	0	0	0	4	0	0	8	5
Skill Enhancement Courses - SEC	3	2	2	2	3	3	0	0	15	9
Foundation / Interdisciplinary Courses - FIC	11	6	0	0	0	0	0	0	17	11
CC / SE / CE / TE / DE / HSS	0	8	12	16	16	16	12	0	80	50
Minor / Open Elective - OE	0	0	3	3	3	3	3	0	15	9
(Research / Design / Industrial Practice / Project / Thesis / Internship) - RDIP	0	0	0	0	0	0	5	12	17	11
Grand Total	18	20	19	23	22	26	20	12	160	100

Note: L-T/D-P/Pr and the class allocation is as follows.

- a) Learning Hours : 30 learning hours are equal to 1 credit.
- b) Lecture/Tutorial : 15 contact hours (60 minutes each) per semester are equal to 1 credit.
- c) Discussion : 30 contact hours (60 minutes each) per semester are equal to 1 credit.
- d) Practical : 30 contact hours (60 minutes each) per semester are equal to 1 credit.
- e) Project : 30 project hours (60 minutes each) per semester are equal to 1 credit.

SEMESTER - I								
S. No	Category	Sub-Category	Course Code	Course Title	L	T/D	P/Pr	C
1	AEC	U AEC	AEC 101	Art of Listening, Speaking and Reading Skills	1	0	1	2
2	VAC	U VAC	VAC 101	Environmental Science	2	0	0	2
3	SEC	S SEC	SEC 101	Analytical Reasoning and Aptitude Skills	1	1	1	3
4	FIC	S FIC	FIC 101	Emerging Technologies	2	0	0	2
5	FIC	S FIC	FIC 111	Chemical Basis of Life	2	0	1	3
6	FIC	S FIC	FIC 112	Mathematics for the Physical World	2	1	0	3
7	FIC	S FIC	FIC 113	Fundamentals of Computing	2	0	1	3
Semester Total					12	2	4	18

SEMESTER - II								
S. No	Category	Sub-Category	Course Code	Course Title	L	T/D	P/Pr	C
1	AEC	U AEC	AEC 107	Effective Writing and Presentation Skills	1	0	1	2
2	VAC	U VAC	VAC 102	Universal Human Values and Ethics	2	0	0	2
3	SEC	S SEC	SEC 103	Entrepreneurial Mindset	2	0	0	2
4	FIC	S FIC	FIC 107	Principles of Management	3	0	0	3
5	FIC	S FIC	FIC 124	Psychology for Everyday Living	3	0	0	3
6	Core	CC	PHY 101	Foundations of Mathematical Physics	3	1	0	4
7	Core	CC	PHY 102	Classical and Modern Physics	3	0	1	4
Semester Total					17	1	2	20

SEMESTER - III								
S. No	Category	Sub-Category	Course Code	Course Title	L	T/D	P/Pr	C
1	AEC	S AEC	AEC 108	Problem Solving Skills	1	0	1	2
2	VAC	U VAC	VAC 103	Co-Curricular Activities	0	0	2	2*
3	VAC	U VAC	VAC 104	Community Service and Social Responsibility	0	0	2	2*
4	SEC	S SEC	SEC 102	Digital Literacy	1	0	1	2
5	Core	CC	PHY 201	Waves and Oscillations	3	0	1	4
6	Core	CC	PHY 202	Advanced Mathematical Physics	3	1	0	4
7	Core	CC	PHY 203	Quantum Mechanics	3	1	0	4
8	Elective	OE		Open Elective / Minor	3	0	0	3
Semester Total					14	2	7	19

SEMESTER - IV								
S. No	Category	Sub-Category	Course Code	Course Title	L	T/D	P/Pr	C
1	AEC	S AEC	AEC 104	Creativity and Critical Thinking Skills	1	0	1	2
2	VAC	U VAC	VAC 103	Co-Curricular Activities	0	0	2	2*
3	VAC	U VAC	VAC 104	Community Service and Social Responsibility	0	0	2	2*
4	SEC	D SEC	SEC 107	Mathematical Modelling of Physical Data	2	0	0	2
5	Core	CC	PHY 204	Electrostatics and Electric Current	3	0	1	4
6	Core	CC	PHY 205	Heat and Thermodynamics	3	0	1	4
7	Core	CC	PHY 206	Electrodynamics	3	0	1	4
8	Core	CC	PHY 207	Introduction to Optics	3	0	1	4
9	Elective	OE		Open Elective / Minor	3	0	0	3
Semester Total					18	0	9	23

SEMESTER - V								
S. No	Category	Sub-Category	Course Code	Course Title	L	T/D	P/Pr	C
1	VAC	U VAC	VAC 103	Co-Curricular Activities	0	0	2	2*
2	VAC	U VAC	VAC 104	Community Service and Social Responsibility	0	0	2	2*
3	SEC	E SEC		Career Skills - I	3	0	0	3
4	Core	CC	PHY 302	Atomic and Molecular Physics	3	0	1	4
5	Core	CC	PHY 301	Statistical Physics	3	0	1	4
6	Core	CC	PHY 303	Analog and Digital Electronics	3	0	1	4
7	Core	CC	PHY 304	Special Theory of Relativity	3	1	0	4
8	Elective	OE		Open Elective / Minor	3	0	0	3
Semester Total					18	1	3	22

SEMESTER - VI								
S. No	Category	Sub-Category	Course Code	Course Title	L	T/D	P/Pr	C
1	VAC	U VAC	VAC 103	Co-Curricular Activities	0	0	2	2
2	VAC	U VAC	VAC 104	Community Service and Social Responsibility	0	0	2	2
3	SEC	E SEC		Career Skills - II	3	0	0	3
4	Core	CC	PHY 307	Solid State Physics	3	0	1	4
5	Core	CC	PHY 305	Nuclear and Particle Physics	3	1	0	4
6	Elective	CE		Core Elective	3	1	0	4
7	Elective	OE		Open Elective / Minor	3	0	0	3
8	RDIP	RDIP	PHY 306	Mentored Project	0	0	4	4
Semester Total					15	2	9	26

SEMESTER - VII								
S. No	Category	Sub-Category	Course Code	Course Title	L	T/D	P/Pr	C
1	Elective	CE		Core Elective	3	1	0	4
2	Elective	CE		Core Elective	3	1	0	4
3	Elective	CE		Core Elective	3	1	0	4
4	RDIP	RDIP	PHY 401	Research Degree Project - I	0	0	5	5
5	Elective	OE		Open Elective / Minor	3	0	0	3
Semester Total					12	3	5	20

SEMESTER - VIII								
S. No	Category	Sub-Category	Course Code	Course Title	L	T/D	P/Pr	C
1	RDIP	RDIP	PHY 402	Research Degree Project - II	0	0	12	12
Semester Total					0	0	12	12

List of Core Electives								
S. No	Category	Sub-Category	Course Code	Course Title	L	T/D	P/Pr	C
CORE ELECTIVE (SEM VI)								
1	Elective	CE	PHY 423	Numerical methods and simulation techniques	2	0	2	4
2	Elective	CE	PHY 427	Introduction to LabVIEW and ZView	0	0	4	4
3	Elective	CE	PHY 422	Introduction to soft matter physics	3	1	0	4
4	Elective	CE	PHY 421	Introduction to Astrophysics	3	1	0	4
CORE ELECTIVE (SEM VII)								
5	Elective	CE	PHY 424	Electronic materials & device physics	2	0	2	4
6	Elective	CE	PHY 425	Device characterization and instrumentation	2	0	2	4
7	Elective	CE	PHY 426	Optical information processing / Optoelectronic Devices	3	0	1	4
8	Elective	CE	PHY 428	Artificial Intelligence in Complex Systems	3	1	0	4
9	Elective	CE	PHY 429	Physics of finances	2	0	2	4
10	Elective	CE	PHY 430	Game theory: Classical and Quantum	2	0	2	4
11	Elective	CE	PHY 431	Battery Materials	3	0	1	4
12	Elective	CE	PHY 432	Battery Design & Testing	2	0	2	4
13	Elective	CE	PHY 433	Beyond Li ion batteries	2	0	2	4
14	Elective	CE	PHY 437	Quantum Computation: Background and Formulation	3	1	0	4
15	Elective	CE	PHY 438	Quantum Computations and Algorithms	3	0	1	4
16	Elective	CE	PHY 439	Quantum Optimization and Computation	3	0	1	4

Minor in Quantum Computation								
S. No	Category	Sub-Category	Course Code	Course Title	L	T/D	P/Pr	C
1	Elective	OE	PHY 274	Foundations of Mathematical Physics	3	0	0	3
2	Elective	OE	PHY 265	Quantum Mechanics	3	0	0	3
3	Elective	OE	PHY 266	Quantum Computation: Background and Formulation	3	0	0	3
4	Elective	OE	PHY 267	Quantum Computations and Algorithms	3	0	0	3
5	Elective	OE	PHY 268	Quantum Optimization and Computation	3	0	0	3

Minor in Device Physics								
S. No	Category	Sub-Category	Course Code	Course Title	L	T/D	P/Pr	C
1	Elective	OE	PHY 246	Solid state physics	3	0	0	3
2	Elective	OE	PHY 269	Electronic materials & smart devices	3	0	0	3
3	Elective	OE	PHY 272	Solid state Ionic Devices	3	0	0	3
4	Elective	OE	PHY 270	Thin film deposition and device fabrication	3	0	0	3
5	Elective	OE	PHY 271	Simulation and Modelling in solid state devices	3	0	0	3
6	Elective	OE	PHY 273	Device characterization and instrumentation	3	0	0	3

Career Skills								
S. No	Category	Sub-Category	Course Code	Course Title	L	T/D	P/Pr	C
1	SEC	SEC	SEC 501	Introduction to R and Python	1	1	1	3

Art of Listening, Speaking and Reading Skills

Course Code	AEC 101	Course Category	AEC				L	T	P	C
							1	0	1	2
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)						
Course Offering Department	Literature and Languages	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

- To develop the students' ability to comprehend spoken language in various contexts and help them build confidence and fluency in speaking through structured activities, discussions, and presentations as well as enhance their reading skills by engaging with a variety of texts, including literary works, informational articles, and academic writings.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Demonstrate effective listening strategies by accurately summarizing and responding to spoken content in various contexts	2	70%	65%
Outcome 2	Students will be able to critically analyze spoken and written texts to identify underlying themes, arguments, and perspectives.	3, 4	75%	70%
Outcome 3	Students will construct and deliver coherent and engaging oral presentations and written responses that integrate information from multiple sources.	5, 6	70%	60%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1					1	1		3	2	3		3			
Outcome 2					1	1			1	3		3			
Outcome 3					1	1			1	3		2			
Average					1	1			1	3	3	3			

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Augmenting Listening skills	9		
	Course introduction and objectives: Importance of LSRW	1	1	1 a
	Listening - Barriers to active listening and steps to Overcome	2	1	1 b
	Listening Comprehension How to take/ make notes (different ways)	2	1	1b, 2a, 2c
	Listening practice: Identifying main ideas, supporting details, and inferences and summarizing key points	2	1	1b, 2a, 2c
	Practice sessions: memory games, Chinese whisper	2	1	NA
Unit 2	Developing Speaking Skills	9		
	Strategies for good speech, Basics of grammatically correct speech	1	2	1a, 2 a, b, c
	Basics of phonetics and intonation	2	2	1a
	Oral presentations: do's and don'ts	1	2	1a
	Speaking Practice: Just a minute/ Impromptu, Story-telling/ Story starters Group discussions,	5	2	NA
Unit 3	Communication and Persuasion	9		
	Verbal Communication and Nonverbal Communication	2	2, 3	1a
	The art of persuasive communication (Ethos, pathos, Logos)	2	2, 3	1a
	Practice sessions (Convince the other Role plays, Self-introduction, Pitching, extempore, public speaking)	5	2, 3	NA
Unit 4	Reading	9		
	Reading strategies (Skimming and scanning, extensive and intensive)	2	2	1c
	Reading and analyzing various texts, including articles, essays, and academic papers	3	2	1c
	Reading Comprehension Practice	4	2	1c, 2a
Unit 5	Integrated Skills and Real-World Application	9		
	Engaging in discussions and debates on current issues	2	3	NA
	Real-world application of language skills (e.g., job interviews, social interactions)	2	3	NA
	Pitching Presentation	5	3	NA

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (60%)			End Semester Exam (40%)
		CLA-1 20%	Mid-1 20%	CLA-2 20%	
Level 1	Remember	20%		40%	30%
	Understand				
Level 2	Apply	60%	40%	40%	30%
	Analyse				
Level 3	Evaluate	20%	60%	20%	40%
	Create				
Total		100%	100%	100%	100%

Recommended Resources

1. Shoba, L. (2017). Communicative English: A Workbook. U.K: Cambridge University Press.
2. Leonardo, N. (2020) Active Listening Techniques: 30 Practical Tools to Hone Your Communication Skills. Rockridge Press
3. Williams, A.J. (2014) Reading Comprehension: How To Drastically Improve Your Reading Comprehension and Speed Reading Fast! (Reading Skills, Speed Reading)

Other Resources

1. <https://learnenglishteens.britishcouncil.org/>
2. <https://www.bbc.co.uk/learningenglish/>
3. <https://www.ted.com/?geo=hi>

Environmental Science

Course Code	VAC 101	Course Category	VAC		L	T	P	C
					2	0	0	2
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)				
Course Offering Department	Environmental Science and Engineering	Professional / Licensing Standards						

Course Objectives / Course Learning Rationales (CLRs)

1. To describe the environmental concepts from ecology and earth science to address real-world problems.
2. To interpret the complex interactions within and between environmental systems and to evaluate evolving environmental problems

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Comprehend the environmental challenges that need attention.	1	80%	70%
Outcome 2	Summarize the types of environmental pollutions and possible effects to society	2	80%	70%
Outcome 3	Classify the natural environmental resources, present state, rate of depletion and future perspectives	2	80%	70%
Outcome 4	Articulate a project-based learning on existing local to global environmental issues	2	80%	70%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design and Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	1	-	1	1	-	1	1	1	2	1	-	1	-	-	-
Outcome 2	1	-	1	1	-	1	2	1	2	1	-	1	-	-	-
Outcome 3	1	-	1	2	1	1	3	2	2	1	-	1	-	-	-
Outcome 4	1	-	1	2	2	1	3	3	2	2	1	1	-	-	-
Average	1	-	1	1	1	1	2	1	2	1	1	1	-	-	-

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Human, Environmental Issues, and Climate Change	6	1	1,2,3
	The man-environment interaction	1	1	1,2,3
	Environmental issues and scales	1	1	1,2,3
	Land use and Land cover change	2	1	1,2,3
	Ozone layer depletion	1	1	1,2,3
	Understanding climate change and adaptation	1	1	1,2,3
Unit 2	Environmental Pollution and Health	7	2	1,2,3
	Understanding pollution; Definitions, sources, impacts on human health and ecosystem	2	2	1,2,3
	Air pollution	1	2	1,2,3
	Water pollution	1.5	2	1,2,3
	Soil pollution	1	2	1,2,3
	Solid waste	1.5	2	1,2,3
Unit 3	Ecosystems, Biodiversity Conservation, and Sustainable Development	9	3	1,2,3
	Ecosystems and ecosystem services	1	3	1,2,3
	Biodiversity and its distribution	1	3	1,2,3
	Threats to biodiversity and ecosystems	1	3	1,2,3
	Overview of natural resources	1	3	1,2,3
	Biotic resources	1	3	1,2,3
	Water resources; Soil and Energy resources	2	3	1,2,3
	Introduction to Sustainable Development Goals (SDGs)- targets and indicators	2	3	1,2,3
Unit 4	Environmental Management, Treaties and Legislation	8	4	1,2,3
	Introduction to environmental laws and regulation	2	4	1,2,3
	Environmental management system	2	4	1,2,3
	Pollution control and management	2	4	1,2,3
	Major International Environmental Agreements; Major Indian Environmental Legislations	2	4	1,2,3
Total Contact Hours		30		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (70%)				End Semester Exam (30%)
		CLA-1 (15%)	Mid-1 (25%)	CLA-2 (15%)	CLA-3 (15%)	
Level 1	Remember	60%	60%	60%	60%	40%
	Understand					
Level 2	Apply	40%	40%	40%	40%	60%
	Analyse					
Level 3	Evaluate	-	-	-	-	-
	Create					
Total		100%	100%	100%	100%	100%

Recommended Resources

1. Rajagopalan, R. (2016) Environmental Studies (3rd edition), Oxford University Press.
2. Sharma, P. D. (2018) Ecology and environment. Rastogi Publications.
3. Anil K. Dey. (2016). Environmental Chemistry. New Age Publisher International Pvt Ltd. ISBN: 9789385923890, 9385923897

Other Resources

Analytical Reasoning and Aptitude Skills

Course Code	SEC 101	Course Category	SEC		L	T	P	C
					3	0	0	3
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)				
Course Offering Department	Mathematics	Professional / Licensing Standards						

Course Objectives / Course Learning Rationales (CLRs)

1. To categorize, apply and use thought process to distinguish between concepts of quantitative methods.
2. To prepare and explain the fundamentals related to various possibilities.
3. To critically evaluate numerous possibilities related to puzzles.
4. Explore and apply key concepts in logical thinking to business problems.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Use logical thinking and analytical abilities to solve quantitative aptitude questions from company specific and other competitive tests.	1	70%	60%
Outcome 2	Solve questions related to Time and Distance and Time and work from company specific and other competitive tests.	3	65%	70%
Outcome 3	Understand and solve puzzle questions from specific and other competitive tests	1	60%	60%
Outcome 4	Make sound arguments based on mathematical reasoning and careful analysis of data.	1	65%	70%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1		3	2	2					2						
Outcome 2		3	2	2					1						
Outcome 3		3	2	1					2						
Outcome 4		3	1	2					2						
Average		3	2	2					2						

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Quantitative Aptitude	14		
	Time, speed and distance	5	1,4	1,4
	Time and work, Pipes and cisterns	9	1,4	1,4
Unit II	Numbers, LCM and HCF.	2	1,4	1,4
	P and C	4	1,4	1,4
	Probability, progressions	4	1,4	1,4
Unit III	Geometry, Mensuration	5	1,2	2,3
	Clocks and calendars	4	1,3	1,4
Unit IV	Linear equation and special equations	5	1,2	1,2
	Quadratic equations	2	1,2	1,2
	Inequalities	2	2,3	2,3
	Sets and Venn diagrams	3	1,2	2,4
Total Contact Hours			45	

Learning Assessment

Bloom's Level of Cognitive Task	Continuous Learning Assessments (50%)								End Semester Exam (50%)	
	CLA-1 20%		Mid-1 20%		CLA-2 20%		Mid -2 15%		Th	Prac
	Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember									
	Understand	40%		50%		40%		50%		50%
Level 2	Apply									
	Analyse	60%		50%		60%		50%		50%
Level 3	Evaluate									
	Create									
Total		100%		100%		100%		100%		100%

Recommended Resources

1. Arun Sharma – How to prepare for Quantitative Aptitude, Tata Mcgraw Hill.
2. R.S. Agarwal – Reasoning. Reasoning for competitive exams – Agarwal.
3. Objective Quantitative Aptitude – Oswaal books.
4. Test of reasoning and numerical ability, quantitative aptitude book – Sahitya bhavan.
5. Radian's Quantitative Aptitude.
6. Quantitative Aptitude and Reasoning – Shyam Saraf / Abhilasha Swarup.
7. Fast track objective Arithmetic – Rajesh Verma.

Emerging Technologies

Course Code	FIC 101	Course Category	FIC	L	T	P	C
Pre-Requisite Course(s)		Co-Requisite Course(s)		2	0	0	2
Course Offering Department	ECE	Professional / Licensing Standards					
		Progressive Course(s)					

Course Objectives / Course Learning Rationales (CLRs)

1. Foster a comprehensive grasp of diverse emerging technologies and their transformative impacts on society and industries.
2. Cultivate critical thinking skills to analyze challenges, opportunities, and applications within each technological domain.
3. Develop practical skills through hands-on experiences and assignments, translating theoretical concepts into real-world applications.
4. Raise awareness of ethical considerations, particularly in the context of Artificial Intelligence, and Machine Learning, IoT, Electric Vehicles, and Semiconductor Technology.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Exhibit a thorough understanding of quantum computing principles, including superposition, entanglement, and interference.	1	80%	90%
Outcome 2	Illustrate understanding by explaining the history, synthesis, and applications of nanomaterial and green hydrogen.	1	80%	90%
Outcome 3	Understand and classify 3D printing technologies.	2	75%	85%
Outcome 4	Demonstrate understanding of the evolution, classification, and applications of UAVs.	2	75%	85%
Outcome 5	Apply knowledge of Artificial Intelligence and Machine Learning, IoT, Electric Vehicles, and Semiconductor Technology.	2	75%	85%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	1	2	2	3	2	2	2	1	2	2	1	1	1	1
Outcome 2	2	1	1	2	3	1	2	2	2	2	2	1	1	1	1
Outcome 3	2	2	2	3	3	3	1	1	3	2	2	1	1	2	2
Outcome 4	2	2	2	2	3	3	2	2	3	2	2	1	2	2	1
Outcome 5	3	2	3	2	2	3	3	2	3	2	2	1	2	2	1
Average	2	2	2	2	3	2	2	2	2	2	2	1	2	2	1

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Quantum Computer and early ideas, classical and quantum computing approaches, superposition, entanglement, and interference in quantum computing.	1	1	1
	QUBITS and their types; representation of data in quantum mechanics.	1	1	1
	Shor's Algorithm, Grover's search algorithm.	1	1	1
	Quantum programming languages; Obstacles in building quantum computers.	1	1	1
	Applications of quantum computers; Opportunities in the field of quantum computing.	1	1	1
	Introduction of quantum communication pillars, quantum network, Heisenberg's uncertainty principle and QKD.	1	1	1
	Challenges in QKD, National Quantum Mission, Future perspectives.	1	1	1
Unit No. 2	Introduction to the nanometer scale. history of nanomaterials	1	2	2
	Synthesis of nanomaterials: Bottom-up and Top-down approach	1	2	2
	Tools & techniques to characterize nanomaterials. Applications of nanomaterials.	1	2	2
	Green Technology: Definition, types of Green Technologies, Green Hydrogen production.	1	2	2
	Challenges involved in the storage of Green Hydrogen produced from PEM based electrolysis.	1	2	2
	Applications of Green Hydrogen.	1	2	2
Unit No. 3	Introduction to 3D printing and additive manufacturing	1	3	3
	Capabilities of 3D printing	1	3	3
	Applications of 3D printing	1	3	3
	Classification based on ASTM	1	3	3
	Working principles of 3D printing technologies	1	3	3
Unit No. 4	Introduction to the evolution of drones	1	4	4
	Classification of drones	1	4	4
	Basic components of drones	1	4	4
	Principles of flight	1	4	4
	Applications of drones	1	4	4
	Drones rules in India, Challenges and future scope.	1	4	4
Unit No. 5	Introduction to Artificial Intelligence, Machine Learning, and Deep learning; applications	1	5	5
	Introduction to the Internet of Things (IoT)	1	5	6
	Applications of IoT	1	5	6
	Basic architecture of the Electric Vehicles (EVs)	1	5	7
	Trends and challenges in EVs	1	5	7
	Introduction to semiconductor mission and chip fabrication	1	5	8

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (100%)				
		CLA-1 20%	CLA-2 20%	CLA-3 20%	CLA-4 20%	CLA-5 20%
Level 1	Remember	90 %	90 %	80 %	75 %	85 %
	Understand					
Level 2	Apply	10 %	10 %	20 %	25 %	15 %
	Analyse					
Level 3	Evaluate					
	Create					
Total		100%	100%	100%	100%	100%

Recommended Resources

1. Quantum Computation and Quantum Information by Michael A. Nielsen, Isaac L. Chuang, 2010.
2. Nanotechnologies: Principles, Applications, Implications and Hands-on Activities – A compendium for educators by Luisa Filippini and Duncan Sutherland, European Commission Research and Innovation, 2013.
3. Additive manufacturing: Principles, Technologies and applications by C.P. Paul and A.N. Jinoop, 2021.
4. Make: Getting Started with Drones - Build And Customize Your Own Quadcopter by Terry Kilby and Belinda Kilby, 2016.
5. Artificial Intelligence: A Modern Approach by Stuart Russell and Peter Norvig, 2010.
6. Fundamentals of Internet of Things: For Students and Professionals by F. John Dian, 2022.
7. Electric Vehicle Engineering by Per Enge, Nick Enge, and Stephen Zoepf, 2021.
8. Fundamentals of Semiconductor Manufacturing and Process Control by Gary S. May and Costas J. Spanos, 2006.

Chemical Basis of Life

Course Code	FIC 111	Course Category	FIC				L	T	P	C
							3	0	0	3
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)						
Course Offering Department	Biological Sciences/ Chemistry	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

- To learn the origin and composition of complex biomolecules and primitive cells, focusing on the chemical reactions that drive the force of life
- To gain foundational knowledge in chemical thermodynamics, covering the basic principles of energy, work, and heat, and understanding the first and second laws of thermodynamics, entropy, spontaneity, reversibility, disorder, and the calculation of Gibbs free energy.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	List and describe biomolecules and cellular structures	2	70%	65%
Outcome 2	Compare different chemical bonding concepts	2	70%	65%
Outcome 3	Analyze and explain cellular processes and structures	4	50%	50%
Outcome 4	Apply thermodynamic principles to chemical systems	3	70%	65%
Outcome 5	Interpret and evaluate energy harvesting reactions in life	6	50%	50%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2
Outcome 1	3	2	3	3	1	1			3		3	3	1	2
Outcome 2	3	3	3	3	1	1		1			3	3	3	2
Outcome 3	3	3	3	2	1	1		1			2	3	2	3
Outcome 4	3	2	3	3	1	1		1			3	3	3	3
Outcome 5	3	3	3	3	1	1		2	3		3	3	2	3
Average	3	2.6	3	2.8	1	1		1.3	3		2.8	3	2.2	2.6

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Life: Origin, composition, and chemistry	9		
	Origin of complex biomolecules and primitive cells	1.5	1	1, 2
	Chemical basis of life- Importance of carbon & water	1.5	1	1, 2
	Synthesis by polymerization; importance of self-assembly; Selectively permeable membranes	1.5	1	1, 2
	Concepts of acids, bases, and buffers	1.5	1	3
	Concepts and numerical problems on pH, K_a , K_b , K_w	1.5		2, 3
	Henderson-Hasselbalch equation	1.5	1	1, 2, 3
Unit 2	Chemical bonding	9		
	Definition and importance; Valence electrons and their role in bond formation	1.5	2	3
	Introduction of Lewis dot structure; Covalent bonds- single, double, and triple bonds	1.5		
	Electronegativity and polarity in covalent bonds; Ionic bonds- transfer of electrons, cations and anions	1.5	2	3
	An elementary idea of lattice structure	1.5		3
	Weak intermolecular associations. Coordinate bonds.	1.5	2	3
	Comparison of bond strengths of different bonds with special relation to biological systems.	1.5	2	3
Unit 3	Life forms and processes	9		
	Prokaryotes and eukaryotes (cell structures and organelles); Virus- lysogenic and lytic cycles	1.5	3	1, 2
	Bacteria- typical bacterial cells, bacterial gene transfer- conjugation, transformation, and transduction	1.5	3	1, 2
	Antibiotic resistance- an emerging threat; Microbiome; Cell cycle- mitosis and meiosis	1.5	3	1, 2
	Structure of DNA and organization of chromosomes	1.5	3	1, 2
	Central dogma- replication in prokaryotes	1.5	3	1, 2
	Central dogma- transcription, and translation in prokaryotes	1.5	3	1, 2
Unit 4	Chemical thermodynamics	9		
	Introduction to energy, work and heat in chemical systems; Differentiating between open, closed, and isolated systems	1.5	4	3
	First law of thermodynamics: conservation of energy, calculation of internal energy changes, concept of enthalpy	1.5	4	3
	Second law of thermodynamics: definition, concept of entropy, calculation and interpretation of entropy changes	1.5	4	3
	Spontaneity, reversibility, and disorder	1.5	4	3
	Gibbs free energy: calculation, predicting feasibility of reaction	1.5	4	2, 3
	Concept of chemical equilibrium	1.5	4	1, 2, 3
Unit 5	Energy harvesting reactions by life forms	9		
	Biological reactions: Enzymes	1.5	5	1, 2
	Equilibrium constants (K_{eq}) of enzymes	1.5	5	1, 2
	Metabolism: Glycolysis	1.5	5	1, 2
	Anaerobic respiration	1.5	5	1, 2
	Aerobic cellular respiration	1.5	5	1, 2
	Fate of food in cellular energy cycle.	1.5	5	1, 2
Total Contact Hours			45	

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (30%)		
		CLA-1 (20%)		Mid-1		CLA-2 (25%)		CLA-3 (25%)				
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac	
Level 1	Remember	40%					40%		40%		30%	
	Understand											
Level 2	Apply	60%					40%		40%		45%	
	Analyse											
Level 3	Evaluate					20%		20%		25%		
	Create											
Total		100%				100%		100%		100%		100%

Recommended Resources

1. Becker's World of the Cell, Global Edition, 9th Edition (2017). Jeff Hardin, Gregory Paul Lewis J. Kleinsmith. Pearson. ISBN-13: 978-1292177694.
2. Life: The Science of Biology, 11th Edition (2017). David Sadava, David M. Hillis, H. Craig Heller, Sally D. Hacker. Sinauer Associates Inc. ISBN-13: 978-1319121078.
3. Chemistry, 12th Edition (2015). Raymond Chang, Kenneth A. Goldsby. McGraw-Hill Education. ISBN-13: 978-0078021510.

Other Resources

Mathematics for Physical World

Course Code	FIC 112	Course Category	FIC				L	T	P	C
			3	0	0	3				
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)						
Course Offering Department	Mathematics	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

1. To enable students from the very beginning of their undergraduate course to know what Mathematics is about.
2. To consolidate and improve students' understanding of mathematics by studying core mathematical topics in more depth.
3. To understand the usefulness, power, and beauty of mathematics

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Interpret mathematical concepts of set theory to solve appropriate problems in both familiar and unfamiliar situations including those in real-life contexts.	2	80%	70%
Outcome 2	Demonstrate basic matrix operations and apply the concepts to real-world applications.	3	80%	70%
Outcome 3	Express derivative as a limit and apply these techniques to graph sketching and optimization problems.	3	70%	65%
Outcome 4	Illustrate the process of integration as anti-differentiation and utilize it to solve several real-world problems.	3	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2
Outcome 1	3	3	3	3				1			2			
Outcome 2	3	3	3	2	1			2			2			
Outcome 3	3	3	3	3	1			2			2			
Outcome 4	3	3	3	3	3			3			2			
Average	3	3	3	3	2			2			2			

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact hours	CLOs Addressed	Reference Used
Unit No. 1	High School Mathematics and its Applications	6		
	Set Theory	1	1	1
	Tutorial-I	1	1	1
	Permutation	1	1	1
	Tutorial -II	1	1	1
	Combination	1	1	1
	Tutorial-III	1	1	1
Unit No. 2	Matrices and System of Linear Equations	10		
	Introduction to Matrices	1	2	3
	Matrix Operations and Algebraic Properties of Matrices	2	2	3
	Tutorial-I	1	2	3
	Determinant and inverse of matrices	2	2	3
	Tutorial-II	1	2	3
	System of Linear Equations and their solutions	2	2	3
	Tutorial-III	1	2	3
Unit No. 3	Differential Calculus	9	3	
	Functions and their graph	2	3	1,2
	Tutorial-I	1	3	1,2
	Limit and Continuity of a function	2	3	1,2
	Derivative of a function and various rules	2	3	1,2
	Increasing and Decreasing functions	1	3	1,2
	Tutorial-II	1	3	1,2
Unit No. 4	Integral Calculus	8		
	Indefinite Integrals	2	4	1,2
	Tutorial-I	1	4	1,2
	Definite Integrals	2	4	1,2
	Tutorial-II	1	4	1,2
	Fundamental Theorem of Calculus	1	4	1,2
	Tutorial-III	1	4	1,2
Unit No. 5	Applications	12		
	Applications of Permutations and Combinations: Formation of molecules	1	1	1,2
	Generation of ON/OFF signals in computing	1	1	
	Tutorial-I	1	1	1,2
	Applications of Matrices: Cryptography by Matrices	1	2	1,2
	Electrical circuit problem	1	2	1,2
	Tutorial-II	1	2	
	Applications of Differential Calculus: Work done and Electric field	1	3	1,2
	Energy behaviour of physical system and computation of Area and volume	1	3	1,2
	Tutorial-III	1	3	1,2
	Applications of Integral Calculus: Kinematics of one-dimensional system	1	4	1,2
	Concept of Slope and analysis of its real-life applications	1	4	1,2
	Blood flow and Cardiac Output	1	4	1,2
	Total Contact Hours		45	

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (60%)				End Semester Assessments (40%)
		CLA-1 (15%)	Mid-1 (25%)	CLA-2 (10%)	CLA-3 (10%)	
Level 1	Remember	30%	20%	25%	25%	20%
	Understand	20%	30%	30%	25%	30%
Level 2	Apply	25%	30%	25%	25%	25%
	Analyse	25%	20%	20%	25%	25%
Level 3	Evaluate					
	Create					
Total		100%	100%	100%	100%	100%

Recommended Resources

1. Kenneth H. Rosen, Discrete Mathematics and Applications, Seventh Edition, Tata McGraw-Hill, 2012.
2. Thomas' Calculus, 14th Edition, Joel R. Hass, Christopher E. Heil, and Maurice D. Weir, 2018.
3. David Hill and Bernard Kolman, Elementary Linear Algebra with Applications, 9th Edition, by Pearson 2019.

Other Resources

Fundamentals of Computing

Course Code	FIC 113	Course Category	FIC				L	T	P	C
			2	0	1	3				
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)						
Course Offering Department	CSE	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

1. Gain basic knowledge in Computer Science and problem solving.
2. Gain basic knowledge in C programming language.
3. Acquire knowledge on Decision making and functions in C.
4. Learn arrays, strings and pointers concept in C.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Describe basics of Computing and problem solving	2	75 %	70%
Outcome 2	Describe C structures, enumerators, keywords, header files and operators	3	70 %	65%
Outcome 3	Illustrate Decision-Making statements and Functions.	3	70 %	65%
Outcome 4	Interpret arrays, strings, and pointers programming in C	3	70 %	65%
Outcome 5	Apply Structures, unions, File handling operations on different scenarios	4	70 %	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	2	1									2	2	3
Outcome 2	3	3	2	1									3	2	3
Outcome 3	3	3	2	2									3	2	3
Outcome 4	3	3	2	2									3	2	3
Outcome 5	3	3	2	2							2	3	2	2	2
Average	3	3	2	2							2	3	2	3	3

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	INTRODUCTION TO COMPUTING	10	1	1
	Fundamentals of Computing, Historical perspective, Early computers	2	1	1,2
	Computing machine. Basic organization of a computer.	2	1	1,2
	ALU, input-output units, and addresses - instructions	2	1	1,2
	Computer Memory	2	1	1,2
	Program counter - variables	1	1	1,2
	Store, arithmetic, input and output	1	1	1,2
Unit No. 2	INTRODUCTION TO PROBLEM SOLVING	10		
	Problem solving: Algorithm / Pseudo code, flowchart, program development steps	2	1	1,2
	Computer languages: Machine, symbolic and high-level language Level languages	2	1	1,2
	Creating and Running Programs: Writing, editing (any editor),	1	1	1,2
	linking, and executing in Linux environment	1	1	1,2
	Lab Experiment 1: GCC Compiler using Linux, various Linux commands used to edit, compile and executing	2	1	1,2
	Lab Experiment 2: a) Calculation of the area of the triangle. b) Swap two numbers without using a temporary variable. c) Find the roots of a quadratic equation	2	1	1,2
Unit No. 3	C PROGRAMMING BASICS	15		
	Structure of a C program, identifiers Basic data types and sizes. Constants, Variables	1	1	1,2
	Arithmetic, relational and logical operators, increment and decrement operator's	1	1	1,2
	Conditional operator, assignment operator, expressions Type conversi Type Conversions,	1	1	1,2
	Conditional Expressions Precedence and order of evaluation, Sample Programs.	1	1	1,2
	SELECTION & DECISION MAKING: if-else, null else, nested if, examples, multi-way selection: switch, else-if, examples.	2	1	1,2
	ITERATION: Loops - while, do-while and for, break, continue, initialization and updating, event and counter controlled loops and examples.	1	1	1,2
		2	1,2	1,2
	Lab Experiment 3: a) Find the sum of individual digits of a positive integer and find the reverse of the given number. b) Generate the first n terms of Fibonacci sequence. c) Generate all the prime numbers between 1 and n, where n is a value supplied by the user.	2	1, 2	1,2
	Lab Experiment 4: a) Print the multiplication table of a given number n up to a given value, where n is entered by the user. b) Decimal number to binary conversion. c) Check whether a given number is the Armstrong number or not.	2	1, 2	1,2
	Lab Experiment 5: Triangle star patterns	2	1, 2	1,2

	<pre> * * * * * I </pre> <pre> * * * * * * * * * * * * * * * * * * * * * II </pre>			
Unit No. 4	FUNCTIONS AND ARRAYS	19		
	User defined functions, standard library functions	1	2,3	1,2
	Passing 1-D arrays, 2-D arrays to functions.	1	2,3	1,2
	Recursive functions - Recursive solutions for Fibonacci series, towers of Hanoi.	2	2,3	1,2
	C Pre-processor and header files	1	2,3	1,2
	Concepts, declaration, definition, storing and accessing elements	1	2,3	1,2
	one dimensional, two dimensional and multidimensional arrays	2	2,3	1,2
	array operations and examples, Character arrays and string manipulations	2	2,3	1,2
	Lab Experiment 6: a) (nCr) and (nPr) of the given numbers b) $1+x+x^2/2+x^3/3!+x^4/4!+\dots+X^n/n!$	2	2,3	1,2
	Lab Experiment 7: a) Interchange the largest and smallest numbers in the array. b) Searching an element in an array c) Sorting array elements.	2	2,3	1,2
	Lab Experiment 8: a. Transpose of a matrix. b. Addition and multiplication of 2 matrices.	2	2,3	1,2
	Lab Experiment 9: a. Function to find both the largest and smallest number of an array of integers. b. Linear search. c. Replace a character of string either from beginning or ending or at a specified location.	2	2,3	1,2
Lab Experiment 10: Pre-processor directives a. If Def b. Undef c. Pragma	1	2,3	1,2	
Unit No. 5	POINTERS	14		
	Concepts, initialization of pointer variables	1	3,4	1,2
	pointers as function arguments, passing by address, dangling memory, address arithmetic	2	3,4	1,2
	character pointers and functions, pointers to pointers	2	3,4	1,2
	pointers and multi-dimensional arrays, dynamic memory management functions	2	3,4	1,2
	command line arguments	1	3,4	1,2

Lab Experiment 10: a. Illustrate call by value and call by reference. b. Reverse a string using pointers c. Compare two arrays using pointers	2	3, 4	1,2,3
Lab Experiment 11: a. Array of Int and Char Pointers. b. Array with Malloc(), calloc() and realloc().	2	3, 4	1,2,3
Lab Experiment 12: a. To find the factorial of a given integer. b. To find the GCD (greatest common divisor) of two given integers. c. Towers of Hanoi	2	3, 4	1,2,3
Lab Experiment 14: a. File copy b. Word, line and character count in a file.	2	5	2, 3, 4
Total Hours		68	

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50 %)								End Semester Exam (50 %)	
		CLA-1 (10 %)		CLA-2 (10 %)		CLA-3 (10 %)		Mid Term(20 %)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	70%		30%		30%		60%	50%	50%	50%
	Understand										
Level 2	Apply	30%		70%		70%		40%	50%	50%	50%
	Analyse										
Level 3	Evaluate										
	Create										
Total		100%		100%		100%		100%	100%	100%	100%

Recommended Resources

1. The C programming Language by Brian Kernighan and Dennis Richie.
2. Programming in C, Pradip Dey and Manas Ghosh, Second Edition, OXFORD Higher Education, 2011.
3. Problem Solving and Program Design in C, Hanly, Koffman, 7th edition, PEARSON 2013.
4. Programming with C by R S Bichkar, Universities Press, 2012.

Other Resources

1. "Programming with C", Byron Gottfried, Mcgraw hill Education, Fourteenth reprint, 2016.

Effective Writing and Presentation Skills

Course Code	AEC 107	Course Category	AEC			
			L	T	P	C
			1	0	1	2
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)		
Course Offering Department	Literature and Languages	Professional / Licensing Standards				

Course Objectives / Course Learning Rationales (CLRs)

1. Demonstrate proficiency in written communication, including the ability to compose clear, grammatically structured and organized written documents, as well as deliver well-structured and engaging presentations
2. Critically analyse and synthesize information from various sources, conduct research, and effectively use evidence to support their arguments in both written assignments and oral presentations, that will enhance their critical thinking and research skills
3. Through a combination of theoretical knowledge and practical exercises, the course aims to enhance students' ability to express ideas clearly, engage an audience, and deliver persuasive and impactful messages in both written and spoken formats.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Develop coherent and well-structured written communication by generating clear and concise written content with logical organization, appropriate grammar	2	90%	90%
Outcome 2	Recognize and analyse the expectations of specific target audiences by adjusting tone, language and style to suit the intended purpose of the audience of written communication and tailoring written content to various formats such as reports, essays, emails, and professional correspondence.	3	90%	90%
Outcome 3	Demonstrate confident Public Speaking with the ability to deliver structured, well-organized, and persuasive presentations by employing visual and interactive aids, storytelling techniques.	3	70%	70%
Outcome 4	Develop strong critical thinking and research skills, enabling them to evaluate information critically, synthesize sources effectively, and provide well-reasoned arguments in their written work and presentations.	2	60%	60%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1					1	1		3	2	3		3			
Outcome 2					1	1			1	3		3			
Outcome 3					1	1			1	3		2			
Outcome 4					1	1			1	3	3	3			
Average					1	1		3	1	3	3	3			

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Basics of Grammatically correct writing	9	1	
	SVO	1	1	1a, 2a,b
	Punctuation	3	1	1a, 2a,b
	Articles and Preposition	2	1	1a, 2a, b
	Tense and Apostrophe	1	1	1a, 2a, b
	Subject-Verb-Agreement	2	1	1a, 2a, b
Unit 2	Categories of Writing	9		
	Emails – different types (Official mails : Requesting Leave/ Enquiring vacancy/ Resigning from job/ requesting internship etc.)	3	1, 2	1b, c
	Notice and Agenda,	2	1, 2	1b, c
	Minutes of Meeting	2	1, 2	1b, c
	Paragraph writing	2	1, 2	1b, c
Unit 3	Advanced Writing	9		
	Writing Cover Letters	3	1, 2	1e
	Resume writing	2	1, 2	1d
	SOP, Abstract	2	1, 2	1g
	Project Report Writing	2	1, 2	2, d
Unit 4	Effective Presentation Techniques	9		
	Understanding the elements of successful presentations – Non-verbal communication in presentaions	3	2,3, 4	1f, 2c
	Creating engaging PPTs	2	2,3, 4	1f, 2c
	Structuring presentations for clarity and impact - Logical flow of topics and connected writing in line with storyboard	2	2, 3, 4	1f, 2c
	Handling Questions and Answers	2	2, 3, 4	1f, 2c
Unit 5	Project Based Learning	15		
	Community Based Project	15	1, 2, 3, 4	NA
	Total Learning Hours	60		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments 60%				End Semester Project 40%
		CLA-1 20%	Mid-1	CLA-2 20%	CLA-3 20%	
Level 1	Remember	20%		20%		50%
	Understand					
Level 2	Apply	40%		40%	50%	50%
	Analyse					
Level 3	Evaluate	40%		40%	50%	
	Create					
Total		100%		100%	100%	100%

Recommended Resources

- 1a) Swan, M. (2005). Practical English usage (Vol. 688). Oxford: Oxford university press.
- 1b) Fenning, C. (2023). Effective Emails: The secret to straightforward communication at work: 1 (Business Communication Skills): Sanage Publishing University Press.
- 1c) Talbot, F. (2009). How to Write Effective Business English: The Essential Toolkit for Composing Powerful Letters, Emails and More, for Today's Business Needs. Kogan Page Publishers
- 1d) Yate, M. (2016). Knock'em Dead Resumes: A Killer Resume Gets More Job Interviews! Simon and Schuster.
- 1e) Yate, M. J. (2018). Ultimate Cover Letters: Master the Art of Writing the Perfect Cover Letter to Boost Your Employability (Vol. 5). Kogan Page Publishers.
- 1f) Carnegie, D. (2013). The Art of Public Speaking. Wyatt North Publishing, LLC.
- 2a. <https://learnenglishteens.britishcouncil.org/>
- 2b. <https://www.bbc.co.uk/learningenglish/>
- 2c. <https://www.ted.com/?geo=hi>
- 2d. https://www.tifr.res.in/~cccf/data/InternDocs/How_to_write_a_structured_Project_Report.pdf

Other Resources

Universal Human Values and Ethics

Course Code	VAC 102	Course Category	VAC	L	T	P	C
				2	0	0	2
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Psychology Department	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

- To cultivate deep understanding of human values by teaching students the core principles of universal human values and their significance.
- To promote ethical decision-making skills by equipping the students with the ability to make ethical choices in life, work, and society.
- To foster a diverse and inclusive ethical perspective by sensitizing the students to diversity, equity, inclusion, gender, and cultural differences.
- To highlight the relevance of ethics in society and professions by showcasing the practical importance of ethics in personal, societal, and professional contexts.
- To address common challenges by preparing the students to overcome obstacles to ethical behaviour, fostering a commitment to universal values.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Evaluate the significance of value inputs in formal education and start applying them in their life and profession	1	70%	80%
Outcome 2	Students will foster diverse and inclusive perspectives, contributing to more equitable and harmonious communities and workplaces	2	70%	70%
Outcome 3	Students will be able to apply ethical principles effectively in their personal and professional lives, leading to improved relationships and ethical practices in society	3	60%	70%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1			3		2		2	3	3	1	1	3			
Outcome 2			3		2		1	3	3	1	1	3			
Outcome 3			3		2		2	3	3	1	1	3			
Average			3		2		1.6	3	3	1	1	3			

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Fundamentals of Human Values and Ethics	7	1	1, 2, 3, 4, 5
	Introduction to human values and ethics.	1		
	Theory of wellbeing	2		
	Purpose and relevance of human values	4		
Unit 2	Culture and Ethical Principles	5	2	1, 2, 3, 4, 5
	Culture and ethics.	2		
	Ethics in the community and society	3		
Unit 3	Ethics and Inclusivity	6	2	1, 2, 3, 4, 5
	Ethics and diversity & inclusion	3		
	Equity, equality, and addressing violence	3		
Unit 4	Ethics in various life spheres	6	3	1, 2, 3, 4, 5
	Ethics in family, society, and workplace	4		
	Ethics in IPR and plagiarism	2		
Unit 5	Overcoming ethical challenges	6	3	1, 2, 3, 4, 5
	Identifying common challenges	3		
	Strategies to overcome challenges	3		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)		
		CLA-1 (10%)	CLA 2 (20%)	CLA-3 (20%)
		Theory	Theory	Theory
Level 1	Remember	50%	50%	50%
	Understand			
Level 2	Apply	50%	50%	50%
	Analyse			
Level 3	Evaluate			
	Create			
Total		100%	100%	100%

Recommended Resources

1. Landau, RS. (2019). Living Ethics. New York: Oxford University Press.
2. Nagarazan, R.S. (2022). A Text book on Professional Ethics and Human Values. New Delhi: New Age International Publisher.
3. Rachels, J., & Rachels, S. (2012). The elements of moral philosophy 7e. McGraw Hill.
4. Singer, P. (1986). Applied Ethics. Oxford: Oxford University Press.
5. Gensler, H., Spurgin, E., & Swindal, J. (2004). Ethics: contemporary readings. Routledge.

Entrepreneurial Mindset

Course Code	SEC 103	Course Category	SEC			
			2	0	0	2
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)		
Course Offering Department	Paari School of Business	Professional / Licensing Standards				

Course Objectives / Course Learning Rationales (CLRs)

- To develop the Entrepreneurial Mindset of Students.
- To provide tools and techniques for navigating the uncertain path of entrepreneurship

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Explain the key entrepreneurship and innovation concepts	1	80%	80%
Outcome 2	Explain concepts of Startup Funding and Pitching	1	80%	80%
Outcome 3	Identify Entrepreneurial Opportunity and ideate solutions	2	80%	70%
Outcome 4	Articulate innovative business plans with sound entrepreneurial concepts.	3	70%	70%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1			2				1								
Outcome 2			2					3		3					
Outcome 3		3	3		2			3	2	3	3				
Outcome 4		3	3		2			3		3	3				
Average		1.5	2.5		1		0.25	2.25	0.5	2.25	1.5				

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
UNIT-1	Introduction to Entrepreneurship	2		
	What and Why of Entrepreneurship		1	1,2
	Need of Entrepreneurship		1	1,2
	Entrepreneurship at SRM-AP		1	1,2
UNIT-2	Entrepreneurial Orientation	4		
	Characteristics of successful entrepreneurs		1,2	1,2
	Mindset shifts: from an employee to an entrepreneur		1,2	1,2
	Overcoming challenges and dealing with failures		1,2	1,2
UNIT-3	Entrepreneurial Skills	4		
	Skillsets of an Entrepreneur		1,2	1,2
	Design Thinking, Growth Mindset		1,2	1,2
	Design Thinking		1,2	1,2
UNIT-4	Entrepreneurial Opportunity & Ideation	2		
	Difference between idea and opportunity		1,2	1,2
	Opportunities in Vibrant Indian Entrepreneurial Ecosystem		1,2	1,2
	Opportunity Recognition (Sources of Opportunity)		1,2	1,2
	Idea Generation		1,2	1,2
UNIT-5	Business Model Canvas	2		
	Why BMC		3	1,2
	Value Proposition		3	1,2
	Customer Discovery		3	1,2
	Customer Relationship		3	1,2
	Channels		3	1,2
	Key Partners		3	1,2
	Key Activities		3	1,2
	Key Resources		3	1,2
	Revenue Structure		3	1,2
	Cost Structure		3	1,2
UNIT-6	Startup Financing & Pitching	2		
	Stages of Fundraising		4	1,2
	Mode of Investment		4	1,2
	Startup Valuation		4	1,2
	From Pitch to Hitch (Pitch Deck)		4	1,2
UNIT-7	Growth Mindset and Sales Ability	2		
	Importance of Sales skill for Entrepreneur		3	1,2
	Sales Techniques		3	1,2
	Developing Growth Mindset		3	1,2
UNIT-8	Developing the Business Plan	12	3,4	1,2
	Total Hours	30		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (100%)			End Semester Exam (40%)
		CLA-1 (10%)	CLA-2 (20%)	CLA-3 (30%)	
Level 1	Remember		20%	20%	100%
	Understand				
Level 2	Apply	100%	80%	80%	
	Analyse				
Level 3	Evaluate				
	Create				
Total		100%	100%	100%	100%

Recommended Resources

1. Bruce R. Barringer, R. Duane Ireland. Entrepreneurship Successfully Launching New Ventures, Pearson; 2020
2. Robert D. Hasrich, Dean A. Shepherd, Michael P. Peters, Entrepreneurship, McGraw Hill, 2021

Other Resources

1. Best business courses online (n.d.). Coursera. <https://www.coursera.org/browse/business/entrepreneurship>

Principles of Management

Course Code	FIC 107	Course Category	FIC				L	T	P	C
							3	0	0	3
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)						
Course Offering Department	Management	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

1. Understand the basic principles and theories of management.
2. Analyse the roles and functions of managers within organizations.
3. Apply management principles to real-world scenarios.
4. Develop critical thinking and problem-solving skills in management contexts

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Demonstrate comprehension of key management theories and concepts.	2	80%	75%
Outcome 2	Evaluate the effectiveness of management practices in different organizational settings.	5	80%	75%
Outcome 3	Apply management principles to solve complex problems and make informed decisions.	4	75%	75%
Outcome 4	Communicate effectively and collaborate with others in managerial roles.	5	75%	70%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1		3	2	3	3	3	1	3	2	3	2	3	3	2	3
Outcome 2		3	3	3	3	2	1	3	2	2	3	3	3	3	3
Outcome 3		3	3	3	3	3	1	3	3	3	3	3	3	2	3
Outcome 4		3	3	3	3	3	1	3	3	3	3	3	3	2	2
Average		3	3	3	3	3	1	3	3	3	3	3	3	2	3

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Introduction to Management			
	Definition and nature of management: Understanding what management entails and its significance in achieving organizational goals. Evolution of management theories: Exploring the historical development of management theories from classical to modern approaches. Functions of management: Introduction to the four primary functions of management – planning, organizing, leading, and controlling. Roles and responsibilities of managers: Analysing the various roles managers undertake, including interpersonal, informational, and decisional roles.	12	1	1,3,5,11
Unit No. 2	Planning and Decision-Making Importance of planning in management: Understanding the role of planning in setting organizational objectives and guiding future actions. Types of plans: Strategic, tactical, and operational plans and their relevance at different organizational levels. Decision-making process and techniques: Exploring the steps involved in decision making and different decision-making techniques such as rational, intuitive, and bounded rationality. Setting goals and objectives: Learning how to establish SMART (Specific, Measurable, Achievable, Relevant, Time-bound) goals and objectives to facilitate effective planning.	12	1, 2	1,2,3,5,12
Unit No. 3	Organizational Structure and Design Organizational structure and its types: Understanding the different types of organizational structures, including functional, divisional, matrix, and network structures. Departmentalization and span of control: Examining how organizations group activities into departments and the implications of span of control on managerial effectiveness. Authority, responsibility, and delegation: Understanding the concepts of authority, responsibility, and delegation in organizational settings and their impact on managerial decision making. Factors influencing organizational design: Analysing internal and external factors that influence organizational design, such as strategy, environment, technology, and size.	12	3	4,5,8,9,11

Unit No. 4	Theories of leadership: Exploring various leadership theories, including trait theory, behavioural theory, contingency theory, and transformational leadership. Leadership styles and their effectiveness: Understanding different leadership styles such as autocratic, democratic, laissez-faire, and their impact on employee motivation and performance. Motivation theories: Examining motivational theories such as Maslows hierarchy of needs, Herzberg two-factor theory, and expectancy theory, and their implications for managerial practice. Techniques for motivating employees: Exploring practical techniques and strategies for motivating employees, including recognition, rewards, job enrichment, and empowerment.	12	1, 3	2,3,8,11,13	
Unit No. 5	Process of control: Understanding the control process, including establishing standards, measuring performance, comparing results, and taking corrective action. Types of control: Exploring different types of control mechanisms, including feedforward, concurrent, and feedback control, and their applications in organizational settings. Performance appraisal methods: Analysing various performance appraisal methods such as graphic rating scales, behaviourally anchored rating scales (BARS), and 360-degree feedback. Continuous improvement and quality management: Understanding the concepts of continuous improvement and quality management, including Total Quality Management (TQM).	12	4	1,7,12	
Total Contact Hours		60			

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50 %)								End Semester Exam (50 %)	
		CLA-1 (10 %)		CLA-2 (10 %)		CLA- 3		Mid Term (30 %)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	30%		30%				50%		30%	
	Understand										
Level 2	Apply	70%		70%				50%		70%	
	Analyse										
Level 3	Evaluate	30%									
	Create										
Total		100%		100%				100%		100%	

Recommended Resources

1. Prasad, L.M. (2021), Principles and Practices of Management, Sultan Chand Publisher, New Delhi.

Other Resources

1. Vasishth, N. & Vasishth, V. (2022), Taxmann's Principles of Management, Taxmann publications.
2. Tripathi, P.C. & Reddy, P.N. (2021), Principles of Management, McGraw Hill
3. Jayashankar, J. (2009) Principles of Management, Margham Publications
4. Mintzberg, H. (2009). Managing. San Francisco, Berrett-Koehler Publishers. P. 26-28.
5. Hannaway, J. (1989). Managers Managing: The Workings of an Administrative System. New York: Oxford University Press, P. 391.
6. Eccles, R. G. & Nohria, N. (1992). Beyond the Hype: Rediscovering the Essence of Management. Boston: The Harvard Business School Press, p. 471.
7. Kotter, J. P. (1982). The General Managers. New York: The Free Press
8. Mintzberg, H. (1973). The Nature of Managerial Work. New York: Harper; Row. P. 371.
9. Kotter, J. P. (1999). "What Effective General Managers Really Do," Harvard Business Review, March–April 1999, pp. 145–159.
10. Sproull, L. S. (1984). "The Nature of Managerial Attention," in L. S. Sproull (ed.)
11. Advances in Information Processing in Organizations. Greenwich, CT: JAI Press 1.
12. Stewart, R. (1967). Managers and Their Jobs. London: Macmillan.
13. Pondy, L. R. (1978). "Leadership Is a Language Game," in M. W. McCall, Jr. and M.
14. M. Lombardo (eds.), Leadership: Where Else Can We Go? Durham, NC: Duke University Press.
15. Mintzberg, H. (2009). Managing. San Francisco, Berrett-Koehler Publishers. P. 26-281.
16. McGregor, J. (2008). "Bezos: How Frugality Drives Innovation," BusinessWeek,
17. April 28, 2008, pp. 64–66. Katz, Robert L., (1974). "Skills of an Effective Administrator." Harvard Business Review, September-October 1974.

Psychology for Everyday Living

Course Code	FIC 124	Course Category	FIC	L	T	P	C
				3	0	0	3
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Psychology	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. To understand the fundamental psychological processes in everyday living.
2. To apply knowledge of psychology in improving self and others.
3. To apply knowledge of psychology in enhancing quality of life.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Explain fundamental psychological processes in everyday living	2	80%	70%
Outcome 2	Describe important theories in psychology in the areas of sensation, perception, personality and learning	2	75%	70%
Outcome 3	Illustrate personal, professional and social applications of psychology	4	75%	60%
Outcome 4	Interpret results from certain personality tests	5	70%	60%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2						1					1			
Outcome 2	1			1				2	1						
Outcome 3	1	1	1				1	1	2	2		2			
Outcome 4	2		2		1			2	1	1		1			
Average	2	1	2	1	1		1	1	2	1		1			

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References
Unit No. 1	Myths and Misconceptions in Psychology	12	1	1
	Definition, nature and goals of psychology	4		
	Common myths and misconceptions about psychology	4		
	Schools of psychology; Basic and applied areas of psychology	4		
Unit No. 2	The Role of Perception and Attitude towards Understanding the World	12	2, 3	2
	Perception: Understanding perception, Gestalt laws of organization, common illusions	3		
	Perceptual constancy - depth perception, size perception, perception of movement	3		
	Attitude formation	3		
	Attitude change	3		
Unit No. 3	Intelligence and Learning	12	2, 3	2
	Definitions and nature of intelligence	3		
	Emotional and social intelligence; Measuring IQ, EQ and SQ	3		
	Fundamentals of learning and its applications	3		
	Memory techniques	3		
Unit No. 4	Understanding the Self	12	2, 4	1
	Definition; Approaches to personality - trait and type	4		
	Psychoanalytical and humanistic theory, Tests of personality - MBTI and NEO-PI	4		
	Identity; Self-concept, self-esteem and self-efficacy	4		
Unit No. 5	Stress, Coping and Quality of Life	12	2, 3	1
	Nature, sources of stress and its reactions	3		
	Factors influencing stress	3		
	Coping with and managing stress - cognitive and behavioural techniques	3		
	Improving quality of life	3		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Exam (50%)
		CLA-1 (15%)	Mid-1 (15%)	CLA-2 (10%)	CLA-3 (10%)	
		Th	Th	Th	Th	
Level 1	Remember	50%	60%	60%	30%	50%
	Understand					
Level 2	Apply	50%	40%	40%	70%	50%
	Analyse					
Level 3	Evaluate					
	Create					
Total		100%	100%	100%	100%	100%

Recommended Resources

1. Baron, R. A. (2001). Psychology. New Delhi: Pearson Education India.
2. Nolen-Hoeksema, S., Fredrickson, B.L. & Loftus, G.R. (2014). Atkinson & Hilgard's Introduction to Psychology. 16th Ed. United Kingdom: Cengage Learning.

Other Resources

1. Morgan, C. T., King, R. A., & Schopler, J. (2004). Introduction to Psychology. New Delhi: Tata McGraw Hill.

Foundations of Mathematical Physics

Course Code	PHY 101	Course Category	CC				L	T	P	C
							3	1	0	4
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)						
Course Offering Department	Physics	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

1. Use tools of vector calculus to physical systems.
2. To solve physical problems involving partial differentiation of multivariable functions.
3. To understand concepts of complex variables with practical applications.
4. Solve first and second-order linear differential equations for various physical systems.
5. To familiarize yourself with the concept of linear vector spaces and their relations with matrix algebra.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Describe the operations of vector algebra, complex numbers, partial differentiation, matrix and linear algebra.	2	70%	65%
Outcome 2	Explain vector and scalar functions, their fields, and partial differentiation concepts.	2	70%	65%
Outcome 3	Apply operational rules to solve problems on vector analysis, matrix, complex numbers, and linear algebra problems	3	70%	65%
Outcome 4	Solve ordinary differential equations (ODEs) using analytical methods and Laplace transformations.	3	70%	65%
Outcome 5	Examine classical physics problems and similar examples using various mathematical operations.	3	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	2	2	-	-	-	-	1	-	-	2	3	1	1
Outcome 2	3	3	2	2	1	-	-	-	2	-	-	2	3	2	1
Outcome 3	3	3	2	3	1	-	-	-	2	-	-	2	3	2	2
Outcome 4	3	3	2	3	2	-	-	2	2	2	-	2	3	2	2
Outcome 5	3	3	2	3	2	-	-	2	2	2	-	3	3	2	2
Average	3	3	2	2.6	1.5	-	-	2	1.8	2	-	2.2	3.0	1.8	1.6

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact hours	CLOs Addressed	Reference Used
Unit No. 1	Vector Algebra	12		
	Introduction to scalars, vectors	1	1	1,2,3
	Rectangular resolution of a vector	1	1	1,2,3
	Scalar product and physical examples	1	1	1,2,3
	Tutorial-I: Scalars, vectors	1	3	1,2,3
	Vector product and physical examples	1	1	1,2,3
	Scalar Triple product and Geometrical Interpretation	1	1, 2	1,2,3
	Coplanar vectors	1	1, 2	1,2,3
	Tutorial –II: Scalars, vectors product	1	3	1,2,3
	Reciprocal Set of vectors	1	1, 2	1,2,3
	Vector product of three vectors	1	1, 2	1,2,3
	Scalar and vector product of four vectors	1	1, 2	1,2,3
	Tutorial-III: Scalars, vectors product	1	3	1,2,3
Unit No. 2	Vector Analysis and Partial Differentiation	12		
	Vector and Scalar Functions and Their Fields.	1	2	1,2,4
	Introduction to partial differentiation	1	2	1,2,4
	Derivative of a Vector Function	1	2	1,2,4
	Gradient of a scalar field and its physical significance	1	2	1,2,4
	Tutorial-I: Partial differentiation	1	3	1,2,4
	Divergence of a scalar field and its physical significance	1	2	1,2,4
	Curl of a vector field and its physical significance	1	2	1,2,4
	Tutorial-II: Divergence and curl	1	3	1,2,4
	Vector integrals: line, surface and volume integral with their examples	1	3	1,2,4
	Gauss-Divergence theorem	1	3	1,2,4
	Stoke's theorem, Vector identities	1	3	1,2,4
	Tutorial-III: Stoke's theorem, Gauss-Divergence theorem	1	3	1,2,4
Unit No. 3	Complex Numbers	12		
	Introduction to complex numbers	1	1, 2	1,2,4
	Algebra of complex numbers	1	1, 2	1,2,4
	Argand diagram	1	1, 2	1,2,4
	Tutorial-I: Complex numbers	1	1,3	1,2,4
	De-Moivre's Theorem	1	1, 2	1,2,4
	Trigonometric, hyperbolic and exponential functions	1	1, 2	1,2,4
	Powers, roots and log of complex numbers	1	1, 3	1,2,4
	Tutorial-II: Complex numbers	1	3	1,2,4
	Applications of complex numbers: Classical mechanics, LCR circuits	1	3, 5	1,2,4
	Determine velocity and acceleration in a curved motion	1	3, 5	1,2,4
	Worked examples – determine velocity and acceleration in curved motion	1	3, 5	1,2,4
	Tutorial-III: Physical examples	1	3	1,2,4
Unit No. 4	Ordinary Differential Equations and Laplace Transform	12		
	Basic concepts of Ordinary Differential Equations (ODE)	1	1, 4	1,2,4
	Linear Order ODE and applications	1	1, 4	1,2,4
	Homogeneous ODEs of second order	1	1, 4	1,2,4
	Wronskian	1	1, 4	1,2,4
	Tutorial-I: Linear ODE	1	3, 4	1,2,4
	Non-homogeneous ODEs and applications	1	1, 4	1,2,4

	Tutorial-II: Non-homogeneous ODEs	1	3	1,2,4
	Laplace Transform: Linearity, Shifting Theorem	1	1, 4	1,2,4
	Unit Step function, Dirac Delta function	1	1, 4	1,2,4
	Laplace Transform of derivatives and integrals	1	1, 4	1,2,4
	Application of Laplace Transform: solving ODEs	1	1, 4, 5	1,2,4
	Tutorial-III: Laplace Transform: solving ODEs	1	3, 4	1,2,4
Unit No. 5	Matrix and Linear Algebra	12		
	Linear equations and matrix formalism	1	1, 3	1,2,3
	Inverse of a square matrix	1	1, 3	1,2,3
	Eigenvalues and eigenvectors of matrices	1	1, 3	1,2,3
	Tutorial-I: Matrices	1	3	1,2,3
	Orthogonal sets of eigenvectors	1	1, 3	1,2,3
	Orthogonal transformations	1	1, 3	1,2,3
	Hermitian and unitary matrices	1	1, 3	1,2,3
	Tutorial-II: Hermitian and unitary matrices	1	3	1,2,3
	Diagonalization of matrices	1	1, 3	1,2,3
	Linear vector spaces, the dual space and the scalar product	1	1, 3	1,2,3
	linear operators, Hermitian operators	1	1, 3	1,2,3
	Tutorial-III: linear operators, Hermitian operators	1	3	1,2,3
	Total Contact Hours		60	

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50 %)								End Semester Exam (50 %)	
		CLA-1 (15 %)		CLA-2 (15 %)		CLA-3 (_ %)		Mid Term (20 %)		Th	Prac
		Th	Prac	Th	Prac	Th	Prac	Th	Prac		
Level 1	Remember	60%		40%				40%		30%	
	Understand										
Level 2	Apply	40%		60%				60%		70%	
	Analyse										
Level 3	Evaluate										
	Create										
Total		100%		100%				100%		100%	

Recommended Resources

1. Kreyszig, E. (2011). Advanced Engineering Mathematics, 10th ed. International Student Version. Wiley Publishers.
2. Riley, K. F., & Hobson, M. P. (2011). Essential Mathematical Methods for the Physical Sciences, 1st ed. Cambridge: Cambridge University Press.
3. Acharya, B. S. (2021). Mathematical Methods for Physicists. IIT Kharagpur. URL: <https://archive.nptel.ac.in/courses/115/105/115105097/>
4. Strang, G. (2008). Computational Science and Engineering I. MIT OpenCourseWare. URL: <https://ocw.mit.edu/courses/mathematics/18-085-computational-science-and-engineering-i-fall-2008/pages/syllabus/>

Other Resources

Classical and Modern Physics

Course Code	PHY 102	Course Category	CC				L	T	P	C
							3	0	1	4
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)						
Course Offering Department	Physics	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

1. Understand and apply concept of kinematics and dynamics
2. Use coordinate systems and transformation
3. Understand and apply concepts of Lagrangian and Hamiltonian formalism in simple systems
4. Understand concepts of modern physics

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Understand concepts of classical mechanics, pseudo forces, central force, atomic structure, and modern physics.	2	70%	65%
Outcome 2	Apply concepts of classical mechanics in kinematics and dynamics problems	3	70%	65%
Outcome 3	Employ concepts pseudoforces e.g., Coriolis force to motion under central forces in real life scenarios	3	70%	65%
Outcome 4	Examine equations of motions using Lagrangian and Hamiltonian formalism in simple systems	3	70%	65%
Outcome 5	Interpret data from classical and modern physics experiments and determine the physical constants and materials properties	3	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	2	3	1	2	-	-	2	2	2	2	3	2	2
Outcome 2	3	3	2	3	1	-	-	-	2	2	2	2	3	2	2
Outcome 3	3	3	2	3	2	-	2	2	2	2	2	2	3	2	2
Outcome 4	3	3	3	3	2	-	-	2	2	2	2	3	3	2	2
Outcome 5	3	3	3	3	2	3	-	2	2	2	2	3	3	2	2
Average	3	3	2.4	3	1.6	2.5	-	2	2	2	-	2.4	3	2	2

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact hours	CLOs Addressed	Reference Used
Unit No. 1	Review of Mechanics	9		
	Introduction to the course	1	1	1 - 4
	Coordinate systems: Cartesian, Cylindrical and Spherical polar	1	1	1
	Transformation between coordination system; matrix for rotation in 2D	1	1	1
	Review of kinematics in 2D	1	1, 2	5,6
	Projectile motion and Freely falling body	1	1, 2	5,6
	Dynamics review: Newton's laws of motion	1	1, 2	5,6
	Free body force diagram	1	1, 2	5,6
	Pulley systems, block on a slope	1	1, 2	5,6
	Solved examples: Mechanics problems	1	2, 4	5,6
Unit No. 2	Pseudo forces	9		
	Inertial and Non-inertial frames of references	1	1	2,3
	Galilean invariance: Example problems	1	1, 3	2,3
	Rotating co-ordinate system	1	1	2,3
	Pseudoforces	1	3	2,3
	Foucault pendulum; variation of 'g'	1	1, 3	2,3
	Coriolis's force: Effect of on cyclone formation, river flow	1	1, 3	2,3
	Effect of Coriolis force on freely falling body, projectile motion	1	1, 3	2,3
	Example problems: Coriolis force effect on projectile motion and Freely falling body	1	3, 4	2,3
	Example problems: Coriolis force	1	1, 3	2,3
Unit No. 3	Central force, Lagrangian and Hamiltonian	9		
	Central forces, Reduction of two body to one body problem; Reduced mass	1	1	2,3
	Equation of motion and force law	1	1, 4	2,3
	Conservation of angular momentum	1	1, 4	2,3
	Effective potential energy and planetary orbits	1	4	2,3
	Kepler's laws planetary motion	1	1	2,3
	Types of constraints, degrees of freedom, Generalized coordinates	1	1, 4	2,3
	Lagrangian of a system, Lagrange's equation	1	4	2,3
	Hamiltonian of a system, Hamiltonian's equations	1	4	2,3
	Solved Examples Simple harmonic motion, block and spring system, at wood machine etc	1	4	2,3
Unit No. 4	Atomic Structure and early models	9		
	Rutherford experiment, Geiger-Marsden experiments	1	1	4
	The Nuclear atom: An atom is largely empty space	1	1	4
	Electron Orbits: The planetary model of the atom and why it fails	1	1	4
	Atomic Spectra: Each element has a characteristic line spectrum	1	1,5	4
	The Bohr Atom	1	1	4
	Energy levels and spectra	1	1, 5	4
	Success and need in the revision of Bohr Atomic Model	1	1	4
	Sommerfeld Atomic model	1	1	4
	Sommerfeld Atomic model: Application	1	1, 5	4
Unit No. 5	Modern Physics	9		
	Electromagnetic Waves	1	1	4
	X-Rays, X-Rays Diffraction	1	1, 5	4
	Photoelectric effect	1	1, 5	4
	Blackbody Radiation	1	1	4
	Planck's Radiation Law	1	1, 5	4
	Physical Significance of Planck's constant	1	1, 5	4
	Quantum Double Slit Experiment	1	1, 5	4
	Davisson and Germer experiment	1	1, 5	4
	De-Broglie Hypothesis: wave particle duality	1	1, 5	4
Electromagnetic Waves	1	1	4	
Total Contact Hours			45	

Course Unitization Plan: Laboratory

Serial No.	Description of Experiments	Required Contact Hours	CLOs Addressed	Ref. Used
1	Measurement tools: Vernier caliper, Screw Gauge, and spectrometer	6	5	7
2	Spring constant	6	1,5	7
3	Compound Pendulum	6	1,5	7
4	Photoelectric effect and Planck's constant	6	1,5	7
5	Observation of spectral lines of a Hydrogen lamp	6	1,5	7
Total contact hours		30		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50 %)								End Semester Exam (50 %)	
		CLA-1 (15 %)		CLA-2 (15 %)		CLA-3 (_ %)		Mid Term (20 %)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	40%	10%	20%	10%			40%		20%	10%
	Understand										
Level 2	Apply	20%	30%	40%	30%			60%		40%	30%
	Analyse										
Level 3	Evaluate										
	Create										
Total		60%	40%	60%	40%			100%		60%	40%

Recommended Resources

1. Griffiths, D. J. (2015). Introduction to Electrodynamics, 4th ed. Pearson Publication.
2. Upadhyaya, J. C. (2019). Classical Mechanics. Himalaya Publishing House.
3. Thornton, S., & Marion, J. (Year). Classical Dynamics of Particles and Systems. Publisher Name.
4. Besier, A., Mahajan, S., & Choudhury, S. R. (2017). Concepts of Modern Physics. Tata McGraw Hill.
5. Serway, R. A., Moses, C. J., & Moyer, C. A. (2013). Physics for Scientists and Engineers with Modern Physics, 9th ed. Singapore: Thomson Learning (Asia Region).
6. Massachusetts Institute of Technology: OpenCourseWare. (2023). Physics I: Classical Mechanics. Retrieved from Massachusetts Institute of Technology: MIT OpenCourseWare <https://ocw.mit.edu/courses/physics/8-01x-classical-mechanics-fall-2023/>
7. Department of Physics, SRM University AP. Engineering Physics lab manuals. Retrieved from Engineering Physics Lab (FIC102) <https://srmmap.edu.in/seas/physics-teaching-lab>

Other Resources

Problem Solving Skills

Course Code	AEC 108	Course Category	AEC				L	T	P	C
							1	0	1	2
Pre-Requisite Course(s)	SEC 101	Co-Requisite Course(s)		Progressive Course(s)						
Course Offering Department	Mathematics	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

1. To categorize, apply and use thought process to distinguish between concepts of quantitative methods.
2. To prepare and explain the fundamentals related to various possibilities.
3. To critically evaluate numerous possibilities related to puzzles.
4. Explore and apply key concepts in logical thinking to business problems.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Use logical thinking and analytical abilities to solve quantitative aptitude questions from company specific and other competitive tests.	1	70%	60%
Outcome 2	Solve questions related to Time and Distance and Time and work from company specific and other competitive tests.	3	65%	70%
Outcome 3	Understand and solve puzzle questions from specific and other competitive tests	1	60%	60%
Outcome 4	Make sound arguments based on mathematical reasoning and careful analysis of data.	1	65%	70%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1		2	2	2	1				1						
Outcome 2		2	1	2	1										
Outcome 3		3	2	2					1						
Outcome 4		3	1	2											
Average		3	2	2	1				1						

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Clocks, Calendars	2	1,4	2,3
	Logical Reasoning Basics, Linear Arrangements, Circular Arrangements	3	1,4	2,3
	Logical Reasoning – Selections, Distributions, Selection decision table, Circular / Tabular arrangements	6	1,4	2,4
	Direction Sense, Blood Relations, Directions, Blood Relations, Problems based on dice and cubes	5	1,4	2,3
Unit No. 2	Data interpretation – Introduction, Line Graph	3	1,4	1,3
	Data interpretation – Bar Graph, Pie-Charts	3	1,4	1,3
	Data Interpretation – Tables, Case lets	3	1,4	1,3
Unit No. 3	Statistics: Basics, Concept Review Questions	2	1,2	4
	Mean, Median, Mode, QD, MD, SD, Advanced Problems.	3	1,2	4
	Functions Basics, Graphs Basics, Functions and Graphs-Advanced.	3	1,2	5
Unit No. 4	Geometry and Mensuration	3	1,2	1
	Venn diagram with two variables and three variables ,logical deductions	3	1,2	2,3
Unit No. 5	Coding Maths – problems based on Number System Coding Maths - Pigeon Hole Principle	3	2,3	1,5
	Coding Maths - Discrete Math Graph Theory	3	1,2	5

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (_ 50%)	
		CLA-1 (10%)		CLA-2 (15%)		CLA-3 (10%)		Mid Term (15%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	20%		25%		20%		25%		25%	
	Understand	20%		25%		20%		25%		25%	
Level 2	Apply	30%		25%		30%		25%		25%	
	Analyse	30%		25%		30%		25%		25%	
Level 3	Evaluate										
	Create										
Total		100%		100%		100%		100%		100%	

Recommended Resources

1. Arun Sharma – How to prepare for Quantitative Aptitude, Tata McGraw Hill.
2. R.S. Agarwal – Reasoning. Reasoning for competitive exams – Agarwal.
3. Logical Reasoning and Data Interpretation for CAT, By Nishit K. Sinha
4. Basic Statistics - B.L. Agarwal.
5. Graph Theory and Its Applications – Jonathan L. Gross

Other Resources

1. Geeks for Geeks
2. Indiabix.
3. M4maths.com

Digital Literacy

Course Code	SEC 102	Course Category	SEC			
			L	T	P	C
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)		
Course Offering Department	ITKM	Professional / Licensing Standards				

Course Objectives / Course Learning Rationales (CLRs)

1. Introduce basic digital skills that are needed in today's 21st century work environment.
2. develop the skills that they need to effectively integrate technology into their respective professional practices.
3. Learn practical-oriented and will have a lot of hands-on exercises.
4. Understand basic and practical digital skills.
5. learn and use software and hardware systems, including the basic troubleshooting.
6. Learn issues pertaining to emerging technologies and creating digital identity in various platforms.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Discuss the importance of Digital Literacy	2	75%	80%
Outcome 2	Compare and contrast collaborative features in digital platforms	3	70%	70%
Outcome 3	Create digital identity profile on LinkedIn	3	75%	75%
Outcome 4	Demonstrate best practices of digitally managed workspace on MS office 365 and G Suite	3	70%	75%
Outcome 5	Identify relevant information from authentic data sources	3	70%	75%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1					3	3		1	2	3		3			
Outcome 2					3	3		1	2	3		3			
Outcome 3					3	3		1	2	3		3			
Outcome 4					3	3		1	2	3		3			
Outcome 5					3	3		1	2	3		3			
Average					3	3		1	2	3		3			

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	COs Addressed	References Used
Unit No. 1	Introduction - Digital Literacy	2	1	1,2,3
	About Digital Literacy	0.5	1	1,2,3
	Importance of digital literacy	0.5	1	1,2,3
	Overview of Computing Systems and Platforms	0.5	1	1,2,3
	Digital Proficiency for Career prospects and Everyday living	0.5	1	1,2,3
Unit No. 2	Know your computer	3	1	1,2,3
	Types of computing	0.5	1	1,2,3
	Accessories & peripherals	0.5	1	1,2,3
	System upkeep & maintenance	0.5	1	1,2,3
	Basic Troubleshooting	0.5	1	1,2,3
	Operating Systems	1	1	1,2,3
Unit No. 3	Microsoft Office Automation software	5	4	1,2,3
	Word Processing	1	4	1,2,3
	Excel - Data Analysis	1	4	1,2,3
	PowerPoint Presentations	1	4	1,2,3
	Digital software tools	1	4	1,2,3
	Best practices	1	4	1,2,3
Unit No. 4	Google Automation Software	3.5	4	1,2,3
	Word Processing	1	4	1,2,3
	Spreadsheet	1	4	1,2,3
	Presentations	1	4	1,2,3
	Best practices	0.5	4	1,2,3
Unit 5	Digital Communication tools	4	2	1,2,3
	Emails Systems - Gmail, MS Outlook, Zimbra, etc	0.5	2	1,2,3
	Calendar Functionality	0.5	2	1,2,3
	Drive - Access Permissions - Best practices	1	2	1,2,3
	Chat functionality and Use	1	2	1,2,3
	Zoom, MS Teams, Google meet, Jiomeet,	1	2	1,2,3
Unit No. 6	Network and Internet	3	1	1,2,3
	Basics of Network	1	1	1,2,3
	Types of browsers, Safety measures, bookmarks	1	1	1,2,3
	Search engines	1	1	1,2,3
Unit No. 7	Digital Identity for Professional Connect activities	5	3	1,2,3
	Social media	1	3	1,2,3
	Dos and Don'ts handling Social Media Accounts	2	3	1,2,3
	Digital Profile	3	3	1,2,3
Unit No. 8	Cybersecurity	1.5	1	1,2,3
	Introduction to Cybersecurity	0.5	1	1,2,3
	Strategies to protect the personal and professional data	0.5	1	1,2,3
	Awareness on various Cyber Attacks	0.5	1	1,2,3
	Security measures for Email, Personal computing systems		1	1,2,3
Unit No. 9	Information and Data Literacy	4	5	1,2,3
	Information & Data Mining Strategies	1	5	1,2,3
	Online resources	2	5	1,2,3
	Understanding on Plagiarism	1	5	1,2,3
Total Contact Hours			30	

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (60%)				End Semester Exam (40%)
		CLA-1 (10%)	Mid-1 (15%)	CLA-2 (10%)	CLA-3 (15%)	
Level 1	Remember	70%	40%	30%	30%	30%
	Understand					
Level 2	Apply	30%	60%	70%	70%	70%
	Analyse					
Level 3	Evaluate					
	Create					
Total		100%	100%	100%	100%	100%

Recommended Resources

1. Digital Literacy (20210401) Kindle Edition by Mandy Reininger (Author), Darrel Karbginsky (Author) Format: Kindle Edition
2. Digital Literacies: Concepts, Policies and Practices (New Literacies and Digital Epistemologies) New Edition by Colin Lankshear (Editor), Michele Knobel (Editor)
3. Read the World: Rethinking Literacy for Empathy and Action in a Digital Age Illustrated Edition by Kristin Ziemke (Author), Katie Muhtar (Author)

Other Resources

Waves and Oscillations

Course Code	PHY 201	Course Category	CC				L	T	P	C
							3	0	1	4
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)						
Course Offering Department	Physics	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

1. Address different types of oscillations and its various applications.
2. Understand transverse and longitudinal waves and their propagation.
3. Learn Doppler's effect and its applications.
4. Gain the basic principles of several optical instruments.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Describe waves, oscillations, and related phenomenon such as Doppler effect, superposition of waves.	2	70%	65%
Outcome 2	Solve equations of motion of simple harmonic motion, damped, forced, coupled oscillations, and other wave motions related problems	2	70%	65%
Outcome 3	Investigate Wave propagation, superposition and related phenomena	3	70%	65%
Outcome 4	Inspect Doppler effect and sound wave propagation	4	70%	65%
Outcome 5	Interpret experimental data from laboratory experiments related to wave and oscillations	4	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	2	3	2	2			2			2	3	2	2
Outcome 2	3	3	2	3	2	2			2			2	3	2	2
Outcome 3	3	3	3	3	2	-			2	2		3	3	1	2
Outcome 4	3	3	3	3	2	2		2	2	2		3	3	2	2
Outcome 5	2	2	3	3	3	3		2	3	2		3	3	3	2
Average	2.8	2.8	2.6	3	2.2	2.3		0.4	2.2	0.6		2.6	3	2	2

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact hours	CLOs Addressed	Reference Used
Unit No. 1	Undamped and Damped Oscillations	9		
	Different types of equilibria (stable, unstable, neutral equilibrium, Saddle points)	1	1	1-7
	Definition of linear and angular S.H.M	1	1	1-7
	Differential equation of S.H.M. and its solution (exponential form)	1	1	1-7
	Composition of two perpendicular linear S.H.Ms. for frequencies 1:1 and 1:2 (analytical method)	1	1	1-7
	Lissajous's figures and its uses	1	1	1-7
	Lissajous's figures and its applications (mechanical, electrical and optical)	1	1	1-7
	Differential equation of damped harmonic oscillator and its solution, discussion of different cases	1	1, 2	1-7
	Logarithmic decrement, Energy equation of damped oscillations	1	1	1-7
	Power dissipation, Quality factor	1	1	1-7
Unit No. 2	Forced Oscillations	9		
	Forced oscillation with one degree of freedom	1	1, 2	1-7
	Differential equation of forced oscillation and its solution (transient and steady state)	1	1, 2	1-7
	Amplitude of forced oscillation	1	2	1-7
	Resonance and its examples: mechanical (Barton's pendulum)	1	2	1-7
	Resonance and its examples: optical (sodium vapor lamp), electrical (LCR Circuit) (description only)	1	1	1-7
	Velocity and Amplitude resonance, Sharpness of resonance	1	2	1-7
	Energy of forced oscillations, Power dissipation	1	1, 2	1-7
	Quality factor and Bandwidth	1	1, 2	1-7
	Equation of coupled oscillations, electrically coupled oscillations	1	2	1-7
Unit No. 3	Wave Motion	9		
	Differential equations of wave motion in continuous media	1	3	1-7
	Group and Phase velocity of a Wave Packet	1	1,2,3	1-7
	Self-Phase Modulation	1	3	1-7
	Equations for longitudinal waves and one dimension solution	1	3	1-7
	Wave propagation in solid, liquid, gases	1	3	1-7
	Equation for transverse waves and its solution (one dimension only)	1	3	1-7
	Transverse Vibrations of a Stretched String	1	3	1-7
	Energy density and intensity of a wave	1	2,3	1-7
	Discussion of seismic waves	1	3	1-7
Unit No. 4	Sound and Doppler Effect	9		
	Definition of sound intensity, loudness, pitch, quality and timber	1	1,4	1-7
	Interference of sound waves, beats, combination tones	1	3,4	1-7
	Application of Fourier's series to the vibration of strings-struck and plucked strings, Energy of a vibration string	1	1,4	1-7
	Acoustic intensity level measurement, Acoustic pressure and its measurement- The Helmholtz resonator; The Kundt's tube	1	1,4	1-7
	Sabine's formula (without derivation), Stroboscope	1	1,4	1-7
	Waves generated by high-speed projectiles, Shock waves	1	1,4	1-7
	Explanation of Doppler Effect in sound, Expression for apparent frequency in different cases	1	1,4	1-7
Doppler Effect in light, symmetric nature of Doppler Effect in light	1	1,4	1-7	

	Applications: Red shift, violet shift, Radar, Speed trap, Width of a spectral line	1	1,4	1-7
Unit No. 5	Superposition of Waves	9		
	Huygens' theory of wave motion	1	1,3	1-7
	Application of Huygens' Principle to Study Refraction and Reflection	1	1,2,3	1-7
	Stationary Waves on a String Whose Ends are Fixed, Nodes and Anti-nodes	1	1,3	1-7
	Superposition of Two Sinusoidal Waves: Stationary Light Waves: Ives' and Wiener's Experiments	1	1,3	1-7
	The Graphical Method for Studying Superposition of Sinusoidal Waves	1	1,2,3	1-7
	The Complex Representation of superposition of waves	1	1,3	1-7
	Interference pattern produced on the surface of Water	1	1,3	1-7
	Temporal and Spatial coherence in wave preparation	1	1,3	1-7
	Superposition of Light waves: Interference by Division of wave front	1	1,3	1-7
	Total Contact Hours		45	

Course Utilization Plan: Laboratory

Serial No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
1	Damping oscillation: Investigating the damping effect of an oscillating spring in high viscosity liquid like oil or glycerine.	2	2, 5	1,2,8
2	Forced oscillation: To investigate resonance in forced oscillations	2	2, 5	1,2,8
3	Compound Pendulum: To determine the acceleration due to gravity (g) by means of a compound pendulum. (ii) To determine the radius of gyration about an axis through the center of gravity for the compound pendulum.	2	1, 5	1,2,8
4	Velocity of sound: To find the velocity of sound in air at room temperature using the resonance column by determining two resonance positions. Use sound velocity to find the unknown frequency of tuning fork. Find the velocity of sound in air at different temperature.	5	4, 5	1,2,8
5	Ultrasonic Diffraction: Determination of velocity of ultrasonic waves in liquid. To find bulk modulus of the given liquid. To find compressibility of the liquid.	5	4, 5	1,2,8
6	Young's Modulus: To determine the Young's modulus of a material of the given beam by non-uniform bending method.	5	5	1,2,8
7	Torsional Pendulum: Determination of rigidity modulus (η) of a thin wire using torsional pendulum	5	1, 5	1,2,8
8	Fly Wheel: Measurement of Moment of Inertia of a Flywheel	4	1,5	1,2,8
	Total contact hours (Experiments + Demo + Extra class)		30 Hours	

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50 %)								End Semester Exam (50 %)	
		CLA-1 (15 %)		CLA-2 (15 %)		CLA-3 (_ %)		Mid Term (20 %)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	40%	10%	20%	10%			40%		20%	10%
	Understand										
Level 2	Apply	20%	30%	40%	30%			60%		40%	30%
	Analyse										
Level 3	Evaluate										
	Create										
Total		60%	40%	60%	40%			100%		60%	40 %

Recommended Resources

1. Roy Chowdhury, D. P. (2015). Advanced Acoustics. Reprint ed, Chayan Publisher.
2. French, A. P. (1971). Vibrations and Waves. Reprint ed, Nelson.
3. Mathur, B. K. (1967). Introduction to Geometrical and Physical Optics. 7th ed, Gopal Printing.
4. Jenkins, F., & White, H. (2017). Fundamentals of Optics. 4th ed, McGraw Hill Education.
5. Kakani, S. L. (2020). Waves, Oscillations, and Acoustics. 2nd ed, CBS Publishers & Distributors.
6. Wood, A. B. (1941). Textbook of Sound. 2nd ed, G. Bell and Sons, Ltd.
7. Mazumdar, K. G., & Ghosh, B. (2010). A Textbook on Light. 3rd revised ed, Sreedhar Publication, India.
8. Shukla, R. K., & Srivastava, A. (2006). Practical Physics. New Age International (P) Limited, Publishers.

Other Resources

1. YouTube. (n.d.). MIT 8.03 Physics III: Vibrations and Waves (1st ed.). USA: YouTube.
https://www.youtube.com/playlist?list=PLUdYlQf0_sSsdOhQ_8jfrAGzbGbj7MXGe
2. YouTube. (n.d.). Introduction to Vibrations and Waves (1st ed.). USA: YouTube.
<https://www.youtube.com/watch?v=DUYxVwXZbcU>
3. YouTube. (n.d.). Wave Interference and Superposition (1st ed.). USA: YouTube.
<https://www.youtube.com/watch?v=CAe3lkYNKt8>

Advanced Mathematical Physics

Course Code	PHY 202	Course Category	CC				L	T	P	C
							3	1	0	4
Pre-Requisite Course(s)	Foundations in Mathematical Physics	Co-Requisite Course(s)		Progressive Course(s)						
Course Offering Department	Physics	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

1. Familiarize about the basic concepts of sequences, series and functions.
2. Understanding Fourier series, Fourier transformations and its applications.
3. Solve homogeneous and nonhomogeneous partial differential equations, and separations of variables.
4. Understanding complex integrals, derivative of analytic functions, contour integrals.
5. To familiarize with Tensors, algebraic operations, and various properties.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Explain the concept of sequences, series, convergence test, various special functions, Fourier transformation, Partial differential equations, complex analysis and tensors	2	70%	65%
Outcome 2	Apply concepts mathematical concepts to solve numerical and analytical problems	3	70%	65%
Outcome 3	Solve partial differential equations and methods of separations of variables	3	70%	65%
Outcome 4	Employ complex integrals and other various properties, deriving derivatives of analytic functions, contour integrals methods.	3	70%	65%
Outcome 5	Illustrate real life examples and applications of Fourier integrals, Fourier transformation, tensor, its various properties, algebraic operations.	3	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	3	2	2				1	2		2	3	1	2
Outcome 2	3	3	3	2	2				2	2		2	3	2	2
Outcome 3	3	3	3	3	3			1	2	2		2	3	2	2
Outcome 4	3	3	3	3	3			2	3	2		2	3	2	2
Outcome 5	3	3	3	3	3			2	3	2		3	2	2	2
Average	3	3	3	2.6	2.6			1.7	2.2	2		2.2	2.8	1.8	2

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact hours	CLOs Addressed	Reference Used
Unit No. 1	Sequences, Series and Special Functions	12		
	Sequence and its examples	1	1	1,2,3,4
	Convergent, divergent sequence, bounded sequence	1	1	1,2,3,4
	Series and examples of series	1	1	1,2,3,4
	Tutorial – I:	1	1,2	1,2,3,4
	Convergent, divergent, oscillatory series	1	1	1,2,3,4
	Properties of Infinite Series, Geometric Series	1	1	1,2,3,4
	Tutorial – II:	1	1,2	1,2,3,4
	Conditions for Convergent series, divergence test, comparison test	1	1	1,2,3,4
	Special functions, examples	1	1	1,2,3,4
	Legendre's equation, Legendre's polynomial, generating function	1	1	1,2,3,4
	Bessel's equation, solution, recurrence formulae	1	1	1,2,3,4
	Tutorial – III	1	1,2	1,2,3,4
Unit No. 2	Fourier Series, Fourier Transform and its applications	12		
	Fourier series	1	1	1,2,3
	Dirichlet's conditions, Advantages of Fourier Series	1	1,2	1,2,3
	Useful integrals	1	1,2,5	1,2,3
	Tutorial – IV	1	2,5	1,2,3
	Even functions, Half range's series	1	1,2	1,2,3
	Change of intervals	1	5	1,2,3
	Fourier transform, Properties of Fourier Transform	1	1,2,5	1,2,3
	Tutorial – V: Fourier transform	1	2,5	1,2,3
	Fourier sine and cosine transforms	1	1,2,5	1,2,3
	Convolution	1	1,2,5	1,2,3
	Parseval's identity of Fourier Transform	1	2,5	1,2,3
	Tutorial – VI: Fourier Transform	1	2,5	1,2,3
Unit No. 3	Partial differential equations	12		
	Partial Differential equations, Order	1	1, 3	1,2,3,5
	Method of forming partial differential equations	1	1, 3	1,2,3,5
	Solution of equation by direct integration	1	1, 3	1,2,3,5
	Tutorial – VII: Partial Differential equations	1	3,5	1,2,3,5
	Lagrange's linear equations, Working rule	1	1, 3	1,2,3,5
	Methods of multipliers	1	1, 3	1,2,3,5
	Partial differential equations non-linear in p, q	1	1, 3	1,2,3,5
	Tutorial – VIII: Partial Differential equations	1	3,5	1,2,3,5
	Homogeneous Partial differential equations	1	1, 3	1,2,3,5
	Non-Homogeneous Partial differential equations	1	1, 3	1,2,3,5
	Method of separation of variables	1	1, 3	1,2,3,5
	Tutorial – IX: Partial Differential equations	1	3,5	1,2,3,5
Unit No. 4	Complex analysis	12		
	Introduction (Line integral), Important definitions	1	1, 4	1,2,3,4
	Cauchy's integral theorem	1	1, 4	1,2,3,4
	Extension of Cauchy's theorem to multiple connected region	1	1, 4	1,2,3,4
	Tutorial - X: Cauchy's integral theorem	1	4,5	1,2,3,4
	Cauchy's integral formula	1	1, 4	1,2,3,4
	Cauchy's integral formula for the derivative of an analytic function	1	1, 4	1,2,3,4
	Geometrical representation	1	1, 4	1,2,3,4
	Tutorial – XI: Cauchy's integral formula	1	4,5	1,2,3,4
	Singular point, removable singularity	1	1, 4	1,2,3,4
	Residue at a pole, at infinity,	1	1, 4	1,2,3,4
	Real definite integrals by contour integrals	1	1, 4	1,2,3,4
	Tutorial – XII: contour integrals	1	4,5	1,2,3,4
Tensors	12			

Unit No. 5	Rank of a Tensor, examples	1	1, 5	1,2,4
	First order Tensors, examples	1	5	1,2,4
	Second order Tensors, examples	1	5	1,2,4
	Tutorial – XIII	1	2, 5	1,2,4
	Tensor of zero order, Tensor of any order, examples	1	5	1,2,4
	Algebraic operations on Tensor	1	5	1,2,4
	Product of two Tensors	1	5	1,2,4
	Tutorial – XIV	1	2, 5	1,2,4
	Symmetric and antisymmetric Tensors	1	5	1,2,4
	Fundamental property of Tensor, Two special tensors	1	5	1,2,4
	Contravariant, covariant, and mixed Tensors	1	5	1,2,4
	Tutorial – XV	1	2, 5	1,2,4
Total Contact Hours		60		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50 %)								End Semester Exam (50 %)	
		CLA-1 (15 %)		CLA-2 (15 %)		CLA-3 (_ %)		Mid Term (20 %)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	60%		40%				40%		30%	
	Understand										
Level 2	Apply	40%		60%				60%		70%	
	Analyse										
Level 3	Evaluate										
	Create										
Total		100%		100%				100%		100%	

Recommended Resources

1. Dass, H. K. (2013). Advanced Engineering Mathematics, XXI revised ed. New Delhi: S. Chand & Company Limited.
2. Arfken, G. B., Weber, H. J., & Harris, F. E. (2013). Mathematical Methods for Physicists, 7th ed. Academic Press, Elsevier.
3. Boas, M. L. (2006). Mathematical Methods in the Physical Sciences, 3rd ed. Wiley
4. Acharya, B. S. (2021). Mathematical Methods for Physicists. IIT Kharagpur. URL: <https://archive.nptel.ac.in/courses/115/105/115105097/>
5. Strang, G. (2008). Computational Science and Engineering I. MIT OpenCourseWare. URL: <https://ocw.mit.edu/courses/mathematics/18-085-computational-science-and-engineering-i-fall-2008/pages/syllabus/>

Other Resources

Quantum Mechanics

Course Code	PHY 203	Course Category	CC				L	T	P	C
							3	1	0	4
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)						
Course Offering Department	Physics	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

1. To understand about the concept of “quantum mechanics” and difference from classical mechanics.
2. To understand the wave – particle duality, photon theory and matter wave.
3. To implement the concept and form a wave equation known as Schrodinger equation.
4. Application of Schrodinger equation to find the properties of microscopic particles.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom’s Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Describe origin of quantum mechanics, wavefunction, uncertainty principle, Schrödinger equation, quantum numbers, Dirac notations and related concepts	2	70%	65%
Outcome 2	Discuss Wave particle duality and superposition principle.	2	70%	65%
Outcome 3	Solve problems related to concepts of quantum mechanics <i>e.g.</i> , particle in 3D box	3	70%	65%
Outcome 4	Interpret quantum tunneling, angular momentum, commutation relation and experiments related to quantum mechanics	3	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	2	2	1				1			2	3	1	1
Outcome 2	3	3	3	2	1				2	1		2	3	2	2
Outcome 3	3	3	3	3	2		2	2	2			3	3	2	2
Outcome 4	3	3	3	3	2		2	2	2			3	3	2	2
Average	3	2.8	2.8	2.5	1.5		2	1.8	1.7			2.5	3	1.8	1.8

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Origin of Quantum Mechanics	12		
	Planck's Radiation Law	1	1	1,2,4
	Photoelectric Effect	1	1	1,2,4
	Numerical problems on Photoelectric effect	1	1,3	1,2,4
	Tutorial I: Photoelectric Effects	1	1,3	1,2,4
	Compton Effect	1	1	1,2,4
	Wave particle duality	1	1,2	1,2,4
	Matter waves, De Broglie hypothesis	1	1	1,2,4
	Tutorial II: Compton Effect	1	1,3	1,2,4
	Concept of wave packet, The principle of Superposition	1	1,2	1,2,4
	Davisson and Germer experiment	1	1	1,2,4
	Phase velocity, group velocity and relation between them	1	1	1,2,4
	Problem practice: Stefan-Boltzmann law	1	1,3	1,2,4
Unit No. 2	Formulation of Quantum Mechanics	12		
	Axioms of Quantum mechanics	1	1, 2	1,2,5,6
	Heisenberg's uncertainty principle with thought experiment	1	1, 2	1,2,5,6
	Conjugate variable	1	2	1,2,5,6
	Tutorial I: Heisenberg's uncertainty principle	1	1,3	1,2,5,6
	Conjugate variables (Fourier transform; Gaussian waveform as example)	1	1	1,2,5,6
	Different forms of uncertainty, Electron diffraction experiment	1	2	1,2,5,6
	Wave function and its physical interpretation,	1	1, 2	1,2,5,6
	Tutorial II: Wave function		1,3	1,2,5,6
	Required properties of wavefunctions	1	2	1,2,5,6
	Double-slit experiment	1	1, 2	1,2,5,6
	Double slit experiment (continuation)	1	1	1,2,5,6
	Tutorial III: Double slit experiment	1	1,3	1,2,5,6
Unit No. 3	Basics of Schrodinger equation I	12		
	Probability Amplitude, Probability Density, Probability	1	1	1,2,6
	Stationary States	1	1	1,2,6
	Expectation value	1	1,3	1,2,6
	Tutorial I: Expectation value, probability density		1,3	1,2,6
	Eigen function and Eigen values	1	3	1,2,6
	Ehrenfest's theorem	1	3	1,2,6
	Schrödinger time dependent equation	1	3	1,2,6
	Tutorial II: Operator and wavefunction	1	1,3	1,2,6
	Schrödinger time independent equation	1	3	1,2,6
	Probability Current Density	1	3	1,2,6
	Stationary States and Bound States	1	3	1,2,6
	Problem practice: Operator, Commutator bracket	1	1,3	1,2,6
Unit No. 4	Basics of Schrodinger equation II	12		
	Free particle, Particle in infinitely deep potential well (1D)	1	3,4	2,3
	Step potential, potential barrier	1	3,4	2,3
	Barrier penetration and tunneling effect	1	3,4	2,3
	Tutorial I: Tunneling effect	1	3,4	2,3
	Dirac potential	1	3,4	2,3
	Harmonic oscillator (one-dimension)	1	1,3	2,3
	Harmonic oscillator (continued)	1	3	2,3
	Tutorial class II: Harmonic oscillator			
	Schrodinger equation in spherical polar coordinate (single electron atom problem)	1	3	2,3
	Quantum numbers n, l, m_l, m_s – Degeneracy	1	1,3	2,3
	Angular Momentum	1	1,3	2,3
	Problem-practice class: Quantum numbers	1	3	2,3

Unit No. 5	Dirac notation in Quantum mechanics	12		
	Definition of an operator in Quantum mechanics	1	1,4	2,3
	Linear vector space & Hilbert Space	1	1,4	2,3
	Inner and outer products	1	1,4	2,3
	Tutorial class I: Operators	1	3,4	2,3
	Linear Operators	1	1,4	2,3
	Hermitian operators: Eigen value and eigenfunction theorems	1	1,4	2, 3
	Position, Momentum and Total energy operator	1	1,3,4	2,3
	Tutorial class II: Eigen value and eigenfunction	1	3,4	2,3
	Commutator brackets- Simultaneous Eigen functions	1	3,4	2,3
	Commutator algebra, Commutation of position and momentum	1	1,4	2,3
	General form of uncertainty principle	1	1,4	2,3
	Problem-practice class: Uncertainty principle	1	3,4	2,3
Total Contact Hours		60		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50 %)								End Semester Exam (50 %)	
		CLA-1 (15 %)		CLA-2 (15 %)		CLA-3 (_ %)		Mid Term (20%)		Th	Prac
		Th	Prac	Th	Prac	Th	Prac	Th	Prac		
Level 1	Remember	60%		40%				40%		30%	
	Understand										
Level 2	Apply	40%		60%				60%		70%	
	Analyse										
Level 3	Evaluate										
	Create										
Total		100%		100%				100%		100%	

Recommended Resources

1. Eisberg, R., & Resnick, R. (2006). Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles, 2nd ed. Wiley.
2. Griffiths, D. (2004). Introduction to Quantum Mechanics, 2nd ed. Pearson.
3. Aruldas, G. (2013). Quantum Mechanics, 2nd ed. PHI.
4. Eisberg, R., & Resnick, R. (2006). Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles, 2nd ed. Edison: Wiley.
5. YouTube. (2014). MIT 8.04 Quantum Physics I. 1st ed, USA: YouTube. Retrieved from <https://www.youtube.com/playlist?list=PLU14u3cNGP61-9PEhRognw5vryrSEVLPr>
6. YouTube. (2023). Introduction to Quantum Mechanics. 1st ed, USA: YouTube. Retrieved from <https://www.youtube.com/playlist?list=PLE0334305C5C04C30>

Other Resources

Creativity and Critical Thinking Skills

Course Code	AEC 104	Course Category	AEC				L	T	P	C
							1	0	1	2
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)						
Course Offering Department	Literature and Language	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

1. Identify key concepts associated with creative problem-solving and critical analysis.
2. Interpret and summarize various models and frameworks used in fostering creative and critical thinking skills.
3. Apply divergent thinking methods to generate innovative solutions to multifaceted problems.
4. Assess and compare the strengths and weaknesses of various critical thinking approaches in decision-making.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Define and describe fundamental concepts and theories related to creativity and critical thinking.	1	80%	80%
Outcome 2	Explain the significance of creativity and critical thinking in problem-solving and decision-making processes.	2	80%	60%
Outcome 3	Implement critical thinking strategies to analyse and evaluate information and arguments effectively.	3	80%	70%
Outcome 4	Analyse and assess the effectiveness of specific creative thinking methods in addressing real-world problems.	4	80%	70%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1			1	3	3			3		3		3		1	3
Outcome 2		3		3	3				3			3	3		3
Outcome 3		3	3		3				3			3	3	3	
Outcome 4		3	3	3	3				3			3	3	3	3
Average		3	2.3	3	3				3			3	3	3	3

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Introduction to Creativity and Critical Thinking	6		
	Introduction to key concepts	2	1,3	1
	Importance in personal and professional contexts	2	1,3	1,2
	Understanding the differences	1	2,3	1,4
	Real-world applications	1	1,3	1,3
Unit No. 2	Overcoming Mental Blocks	6		
	Identifying and addressing barriers	3	1	14
	Exercises for mental flexibility	3	4	1,2
Unit No. 3	Critical Thinking Skills	6		
	Recognizing common pitfalls	1	1,3	1,2
	Examples and group discussion	1	2,3	1,2
	Techniques for assessing information credibility	2	1,3	1
	Case studies and research exercises	2	1,3	3
Unit No. 4	Application of Creative Solutions	6		
	Practical problem-solving exercises	1	1,3	1,4
	Group projects and case studies	2	2,3	2,3
	Integrating ethics into creative and critical thinking	1	1,3	1
	Discussions on ethical dilemmas and decision-making	2	1,3	3
Unit No. 5	Application of Creative Solutions	6		
	Quizzes on concepts and techniques	1	1,3	1,2
	Individual and group assignments	1	2,3	1,2
	Applying creativity and critical thinking to a real-world scenario	2	1,3	1
	Presentation and peer evaluation	2	1,3	3
Total Contact Hours			30	

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (75%)								End Semester Exam (45%)	
		CLA-1 (20%)		CLA- 2 (20%)		CLA-3 (20%)		Mid Term			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Proj
Level 1	Remember	30%					10%				
	Understand										
Level 2	Apply	70%		100%			90%				100%
	Analyse										
Level 3	Evaluate										
	Create										
Total		100%		100%		100%				100%	

Recommended Resources

1. Creative Confidence: Unleashing the Creative Potential Within Us All by Tom Kelley and David Kelley
2. Critical Thinking: An Introduction by Alec Fisher
3. Think Like a Freak: The Authors of Freakonomics Offer to Retrain Your Brain by Steven D. Levitt and Stephen J. Dubner
4. Creative Intelligence: Harnessing the Power to Create, Connect, and Inspire by Bruce Nussbaum

Other Resources

Mathematical Modelling of Physical Data

Course Code	SEC 107	Course Category	SEC				L	T	P	C
			2	0	0	2				
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)						
Course Offering Department	Mathematics	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

1. To gain a foundational understanding of statistics and probability, and error analysis.
2. To know different types of mathematical models used to understand a data set.
3. To construct appropriate mathematical through formulation of real-life problems, solve those problems and validate the results.
4. To develop job-relevant skills with hands-on projects.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Idea of basics of statistics and probability, and different data fitting methods	2	70%	65%
Outcome 2	Knowledge of error analysis using a given data set	3	70%	65%
Outcome 3	Understand different types of mathematical models for fitting the data and solve those numerically	3	70%	65%
Outcome 4	Learn to write a report using Latex	4	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	3	1	2							2	2	2	2
Outcome 2	3	3	3	3	3				2			2	2	2	3
Outcome 3	3	3	3	3	3				2			2	3	2	3
Outcome 4	3	3	3	3	3				2			2	3	2	3
Average	3	3	3	3	3				2			2	3	2	3

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Probability distributions	1	1	1
	Mean, Variance, and Standard deviations	1	1	1
	Central limit theorem	1	1	1
	Gradient decent Method	1	1	1
	Regression	1	1	1
Unit 2	Precision and accuracy	1	1,2	1
	Significant digits and round-off	1	1,2	1
	Error propagation	1	1,2	1
	Weighted average	1	1,2	1
	Least-square fitting and chi-squared test	1	1,2	1
Unit 3	Different types of Mathematical models	2	3	2,3
	Linear Modeling	2	3	2,3
	Exponential Modeling	2	3	2,3
	Modeling with Differential Equations	2	3	2,3
	Implementation of some of these models using Python	3	3	4
Unit 4	Basics of Latex	3	4	5
	Preparing a report using Latex	3	4	5
Total Contact Hours		30		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Exam (50%)	
		CLA-1 (15%)	Mid-1 (20%)	CLA-2 (15%)	Mid-2 ()		
Level 1	Remember	40%	60%	40%		30%	50%
	Understand						
Level 2	Apply	60%	40%	60%		70%	50%
	Analyse						
Level 3	Evaluate						
	Create						
Total		100%	100%	100%		100%	

Recommended Resources

1. An introduction to Numerical methods and analysis, 2nd Edition, James F Epperson, Wiley Publication
2. Mathematical Modeling, Mark M. Meerschaert (<https://www.stt.msu.edu/~mcubed/modeling.html>)
3. Precalculus: Mathematical Modeling” by Joseph W. Cutrone (<https://www.coursera.org/learn/precalculus-mathematical-modelling#modules>)
4. Modelling with Differential Equations” by Marleen Keijzer et al (<https://online-learning.tudelft.nl/courses/modelling-with-differential-equations/>)
5. Latex for Beginners (https://www.colorado.edu/aps/sites/default/files/attached-files/latex_primer.pdf)

Other Resources

Electrostatics and Electric Current

Course Code	PHY 204	Course Category	CC				L	T	P	C
							3	0	1	4
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)						
Course Offering Department	Physics	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

1. To understand the behaviour of electric charges and their interactions with magnetism.
2. To understand the interaction of electric and magnetic fields in materials.
3. To learn AC circuit elements and their behaviour.
4. To learn the applications of AC circuits in different systems.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Explain key concepts of vector analysis, electrostatics, electrical circuits, components, transient circuit, and related properties	1	70%	65%
Outcome 2	Apply the concepts to solve problems on electrostatics, transient circuit, and related properties	3	70%	65%
Outcome 3	Investigate electrostatic properties of electric dipole, quadrupole and dielectric materials.	3	70%	65%
Outcome 4	Illustrate practical applications dielectric, electrical components and various AC circuits	3	70%	65%
Outcome 5	Interpret experimental data from laboratory experiments related to electrostatics, electrical circuits and components	4	75%	70%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Life Long Learning	PSO 1	PSO 2
Outcome 1	3	3	2	3	1	-		2	2		2	3	2	2
Outcome 2	3	3	2	3	1	-		2	2		2	3	2	2
Outcome 3	3	3	3	3	2	1	2	2	2		2	3	2	3
Outcome 4	3	3	3	3	2	3	2	3	2		3	3	2	3
Outcome 5	3	3	3	3	3	3	2	3	2		3	3	3	3
Average	3	3	2.6	3	1.8	2.3	2	2.4	2		2.4	3	2.2	2.6

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	Ref. Used
Unit No.1	Electrostatics	9		
	Vector calculus	1	1,2	1, 2, 3, 6
	Spherical and cylindrical coordinate systems	1	1,2	1, 2, 3, 6
	Gradient, divergence, and curl	1	1,2	1, 2, 3, 6
	Line, surface, and volume integral.	1	1,2	1, 2, 3, 6
	Gauss and Stoke's theorem	1	1,2	1, 2, 3, 6
	Coulomb's law & Electrostatic Force	1	1,2	1, 2, 3, 6
	Superposition principle	1	1,2	1, 2, 3, 6
	Electric field due to point charge & group of charges	1	1,2	1, 2, 3, 6
	Electric field due to continuous charge distribution	1	1,2	1, 2, 3, 6
Unit No. 2	Application of Gauss Law and Boundary Value Problems	9		1, 2, 3
	Concept of electric flux – introduction to Gauss Law	1	1, 2	1, 2, 3
	ES field due infinite wire and infinite sheet of charge	1	1, 2	1, 2, 3
	ES field due to conducting and insulating sphere	1	1, 2	1, 2, 3
	ES field due to conducting and insulating cylinder	1	1, 2	1, 2, 3
	Worked examples of boundary value problems	1	1, 2	1, 2, 3
	Conducting sphere in a uniform field	1	1, 2	1, 2, 3
	Electrostatic potential – inter-relation with ES field	1	1, 2	1, 2, 3
	Electro-static energy of the system of point charges and charge distribution – worked examples	1	1, 2	1, 2, 3
	Problems	1	1, 2	1, 2, 3
Unit No. 3	Electric dipole, dipole moment and quadrupoles	9		1, 2, 3, 6
	Electric potential due to dipole	1	1, 3	1, 2, 3, 6
	Electric field intensity due to dipole	1	1, 3	1, 2, 3, 6
	Torque on electric dipole in external electric field	1	1, 3	1, 2, 3, 6
	Effect of external electric field on non-polar molecules	1	1, 3	1, 2, 3, 6
	Induced dipole moment – Image charge formation	1	1, 2, 3	1, 2, 3, 6

	Dipole-dipole interaction in a plane, out of plane and positioned at certain angle	1	1, 3	1, 2, 3, 6
	Dipoles in Uniform and non-uniform electric field	1	1, 2, 3	1, 2, 3, 6
	Potential near an Arbitrary Charge Distribution	1	1, 3	1, 2, 3, 6
	Quadrupole Moment, Two Simple Quadrupoles, Qualitative discussion on Octuplet Moment	1	1, 3	1, 2, 3, 6
Unit No. 4	Dielectric materials	9		1, 2, 3
	Polar and non-polar molecules	1	1, 3	1, 2, 3
	Atomic polarizability and related problems	1	1, 2, 3	1, 2, 3
	Electric polarization of dielectric material	1	1, 3	1, 2, 3
	Electric polarization vector, Strength of dielectric material and Dielectric breakdown	1	1, 3	1, 2, 3
	Electric displacement and Gauss law in dielectric, Relation between three electric vectors (E, D and P)	1	1, 2, 3	1, 2, 3
	Plane Parallel Capacitor, Capacitor filled with dielectric	1	2, 3, 4	1, 2, 3
	Coaxial Cylindrical Capacitor, Concentric Spherical Capacitor	1	2, 3	1, 2, 3
	Capacitors in Parallel, Capacitors in Series	1	2, 3, 4	1, 2, 3
	Charging and discharging of Capacitor using High Resistance.	1	1,2,3	1, 2, 3
Unit No. 5	Alternative current and transient circuit	9		1, 2, 3
	Revisiting Resistors: Series and Parallel resistance. Color code of resistors. Kirchhoff's Law's.	1	1, 4	1, 2, 3
	Introduction to inductors: self and mutual inductance.	1	1, 4	1, 2, 3
	Transient current in DC Circuits: LR, LC, LCR circuits.	1	1, 2, 4	1, 2, 3
	Alternating currents: basic ideas of generation, mean and RMS values	1	1, 2, 4	1, 2, 3
	Behaviour of resistor (R), capacitor (C) and inductor (L) in AC circuits: Introduction of Phasor Diagram	1	1, 4	1, 2, 3
	Current and Voltage in LR & CR circuits in AC using phasor diagram: Impedance triangle.	1	1, 4	1, 2, 3
	LCR circuit, series and parallel resonance, bandwidth, and Q-value.	1	1, 2, 4	1, 2, 3
	Losses in A. C. circuits: the skin effect & eddy current.	1	1, 2, 4	1, 2, 3
	Step-up and Step-down transformer. Properties of ideal transformer.	1	1, 4	1, 2, 3
Total Contact Hours		45		

Course Unitization Plan: Laboratory

Serial No.	Description of Experiments	Required Contact Hours	CLOs Addressed	References
1	a) To use a multimeter for measuring Resistances, A/C and DC Voltages, AC and DC Currents, Capacitances, and Frequencies b) Determine electrical parameters of commercially available electronic components	4	1,5	4,5
2	To determine the capacitance of a parallel plate capacitor by the measurement of charge. To measure the capacitance as a function of area and distance between the plates.	4	3, 5	4,5
3	To determine the dielectric constant of different dielectric materials	2	3, 5	4,5
4	To determine the value of high resistance by leakage method	4	5	4,5
5	To study the response curve of a Series LCR circuit and determine its (a) Resonant Frequency, (b) Impedance at Resonance and (c) Quality Factor Q, and (d) Band Width	4	4, 5	4,5
6	To study the response curve of a Parallel LCR circuit and determine its (a) Anti-Resonant Frequency and (b) Quality Factor Q	4	4, 5	4,5
7	To find the mutual inductance of two coils	4	4, 5	4,5
8	To study the working of step-down/step-up transformer	4	4, 5	4,5
Total contact hours			30	

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50 %)								End Semester Exam (50 %)	
		CLA-1 (15 %)		CLA-2 (15 %)		CLA-3 (_ %)		Mid Term (20 %)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	40%	10%	20%	10%			40%		20%	10%
	Understand										
Level 2	Apply	20%	30%	40%	30%			60%		40%	30%
	Analyse										
Level 3	Evaluate										
	Create										
Total		60%	40%	60%	40%			100%		60%	40 %

Recommended Resources

1. Griffiths, D. J. (2015). Introduction to Electrodynamics (4th ed.). Pearson Publication.
2. Purcell, E. (2017). Electricity and Magnetism (In SI Units): Berkeley Physics Course - Vol.2. McGraw Hill Education.
3. Jackson, J. D. (2007). Classical Electrodynamics (3rd ed.). Wiley.
4. Mazumdar, K. G., & Ghosh, B. (2004). Advanced Practical Physics (Revised ed.). Sreedhar Publishers.
5. Shukla, R. K., & Srivastava, A. (2006). Practical Physics. New Age International (P) Limited Publishers.
6. Massachusetts Institute of Technology: OpenCourseWare. (2023). Physics II: Electricity and Magnetism. Retrieved from Massachusetts Institute of Technology: MIT OpenCourseWare <https://ocw.mit.edu/courses/physics/8-02x-electricity-and-magnetism-fall-2023/>

Other Resources

Heat and Thermodynamics

Course Code	PHY 205	Course Category	CC				L	T	P	C
							3	0	1	4
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)						
Course Offering Department	Physics	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

1. To understand the concept of ideal gas equation and the kinetic theory of gases.
2. Analyse the basic concepts behind the various laws of thermodynamics.
3. Discuss the various thermodynamic relations.
4. Understand the concept of thermoelectricity.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Explain fundamental aspects of kinetic theory of gas, laws of thermodynamics, free energy, entropy and thermoelectric effect.	2	70%	65%
Outcome 2	Review theoretical basics and experimental tools related to Thermal equilibrium and related concepts.	2	70%	65%
Outcome 3	Solve problems on concepts of thermodynamics such as first law, second law, entropy etc.	3	70%	65%
Outcome 4	Construct Maxwell's thermodynamics relations and Clausius-Clapeyron's equations	3	70%	65%
Outcome 5	Analyze and Interpret experimental data from laboratory experiments related to heat and thermodynamics	4	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Life Long Learning	PSO 1	PSO 2
Outcome 1	3	2	2	2	2	-		2	2		2	3	1	2
Outcome 2	3	3	3	3	2	3		2	2		3	3	3	2
Outcome 3	3	3	3	3	2	-	2	2	2		2	3	2	2
Outcome 4	3	3	3	3	2	-	2	3	2		2	3	2	2
Outcome 5	3	3	3	3	2	3	2	3	2		3	3	3	2
Average	3	2.8	2.8	2.8	2	3		2	2.4	2	2.4	3	2.2	2

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Kinetic Theory of Gases	9		
	Ideal Gas, Ideal Gas Equation	1	1	1, 2, 6, 7
	Assumptions of Kinetic Theory of gases, Pressure of an ideal gas (no derivation)	1	1	1, 2, 6, 7
	Kinetic interpretation of Temperature, Ideal Gas equation	1	1	1, 2, 6, 7
	Degree of freedom, Law of equipartition of energy and its applications for specific heats of gases	1	1,3	1, 2, 6, 7
	Maxwell distribution of gas molecules speed (derivation)	1	1,2	1, 2, 6, 7
	Experimental verification of Maxwell's Law of speed distribution	1	1,2	1, 2, 6, 7
	Most probable speed, average and root mean square (r.m.s.) speed, Mean free path	1	1,3	1, 2, 6, 7
	Real gases, Andrew's experiment,	1	1	1, 2, 6, 7
	Vander Waal's equation of ideal gases, interpretation of a and b parameters	1	1,2	1, 2, 6, 7
Unit No. 2	Basic Concepts of Thermodynamics	9		
	Thermodynamic state of a system, Thermal Equilibrium	1	1,2	1, 2
	Zeroth law of Thermodynamics	1	1,2	1, 2
	Internal Energy of System-Concept of heat and temperature	1	1,2	1, 2
	Equation of State: The Ideal Gas Equation, Indicator Diagram	1	1, 2	1, 2
	First law of Thermodynamics	1	1, 3	1, 2
	Thermodynamic Process-Isothermal, Adiabatic, Isobaric, Isochoric	1	1, 3	1, 2
	Adiabatic relations of system for perfect gas	1	1, 3	1, 2
	Work done during Isothermal and Adiabatic changes	1	1, 3	1, 2
	Reversible and Irreversible processes in thermodynamics	1	1	1, 2
Unit No. 3	Second Law of Thermodynamics: Entropy	9		
	Conversion of Heat into Work and its converse	1	1,2	1, 2, 6, 7
	Carnot's Cycle and Carnot's Heat Engine and its efficiency	1	2, 3	1, 2, 6, 7
	Second law of Thermodynamics: Statements, Carnot Theorem	1	2, 3	1, 2, 6, 7
	Entropy, Principle of Increase in Entropy	1	2, 3	1, 2, 6, 7
	Generalized form of the First and Second laws	1	1,2	1, 2, 6, 7
	Entropy changes for an Ideal Gas	1	1, 3	1, 2, 6, 7
	Entropy changes for van der Waals' gas	1	1,2,3	1, 2, 6, 7
	Otto cycle, Diesel cycle and its comparison, efficiencies	1	1,2,3	1, 2, 6, 7
	The Carnot Refrigerator, Air conditioning: principle and its applications	1	1,2,3	1, 2, 6, 7
Unit No. 4	Thermodynamic relations and Equation of state	9		
	Maxwell's thermodynamics relations	1	2,4	2,3
	How to remember the maxwell's relations	1	2,4	2,3
	Significance of Maxwell's relations	1	2,4	2,3
	Thermodynamics relations with heat capacities	1	2,4	2,3
	Three TdS equations	1	2,4	2,3

	Helmholtz Free energy	1	2,4	2,3
	Gibbs Free energy	1	2,4	2,3
	Enthalpy	1	2,4	2,3
	Clausius-Clapeyron's equations	1	2,4	2,3
Unit No. 5	Thermoelectric effect	9		
	Seebeck effect	1	1,2,5	2,3
	Peltier effect	1	1,2,5	2,3
	Thomson effect	1	1,2,5	2,3
	Full thermoelectric equations	1	1,2,5	2,3
	Thomson relations	1	1,2,5	2,3
	Thermoelectric generators	1	1,2,5	2,3
	Applications of Thermoelectric generators and its applications	1	1,2,5	2,3
	Thermocouples, Temperature measurement	1	1,2,5	2,3
	Thermoelectric materials	1	1,2,5	2,3
Total Contact Hours		45		

Course Unitization Plan: Laboratory

S.No.	Description of Experiments	Required Contact Hours	CLOs Addressed	References
1	To study the thermal conductivity of a given material in a constant temperature gradient	4	2,5	2, 4, 5
2	Determine the specific heat capacity of given metal and insulating materials by heat exchange method	3	2,5	2, 4, 5
3	Measurement of Joule's constant (J) by electrical method	4	2,5	2, 4, 5
4	To find coefficient of thermal expansion of copper, aluminum and brass using their pipes	6	2,5	2, 4, 5
5	Determination of the boiling point of a liquid by platinum resistance thermometer	4	2,5	2, 4, 5
6	a) Development of Thermocouple circuit using commercially available thermocouple b) To study the variation of Thermo-EMF of a thermocouple with Difference of temperature of its two junctions	6	2,5	2, 4, 5
7	Determination of the unknown temperature by thermocouple	3	2,5	2, 4, 5
Total contact hours		30 Hours		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50 %)								End Semester Exam (50 %)	
		CLA-1 (15 %)		CLA-2 (15 %)		CLA-3 (___%)		Mid Term (20 %)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	40%	10%	20%	10%			40%		20%	10%
	Understand										
Level 2	Apply	20%	30%	40%	30%			60%		40%	30%
	Analyse										
Level 3	Evaluate										
	Create										
Total		60%	40%	60%	40%			100%		60%	40 %

Recommended Resources

1. Gupta, A. B., & Roy, H. P. (2010). Thermal Physics (Heat & Thermodynamics), Revised ed. Calcutta: Books and Allied (P) Ltd.
2. Zemansky, M. W., & Dittman, R. H. (2015). Heat and Thermodynamics, 7th ed. McGraw-Hill International Editions.
3. Young, H. D., Freedman, R. A., & Ford, L. (2015). University Physics with Modern Physics with Mastering Physics, 12th ed. Pearson Education.
4. Mazumdar, K. G., & Ghosh, B. (2004). Advanced Practical Physics, Revised ed. Sreedhar Publishers
5. Shukla, R. K., & Srivastava, A. (2006). Practical Physics. New Age International (P) Limited Publishers.
6. DeVoe, H. (2008). Thermodynamics and Kinetics. 1st edition, Cambridge, MA: MIT OpenCourseWare.
<https://ocw.mit.edu/courses/chemistry/5-60-thermodynamics-kinetics-fall-2008/>
7. Krupanidhi, S. B. (Year). Heat and Thermodynamics. 1st edition, Bangalore: NPTEL, IISc Bangalore.
<https://nptel.ac.in/courses/115/108/115108108/>

Other Resources

Electrodynamics

Course Code	PHY 206	Course Category	CC				L	T	P	C
							3	0	1	4
Pre-Requisite Course(s)	PHY 115	Co-Requisite Course(s)	PHY 211	Progressive Course(s)						
Course Offering Department	Physics	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

1. To understand the general concepts in Magnetostatics.
2. To learn the fundamentals of magnetism and magnetic materials.
3. To develop knowledge base regarding electromagnetic induction.
4. To explore and learn about Maxwell's Equation.
5. To investigate reflection, transmission and polarization of EM Waves

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Explain fundamental concepts of magnetostatics, magnetic materials, electromagnetic induction, electromagnetic wave and related effects.	2	70%	65%
Outcome 2	Solve problems related to magnetostatics, magnetic materials, electromagnetic induction, electromagnetic wave and related concepts	3	70%	65%
Outcome 3	Correlate electromagnetic induction in real life examples	3	70%	65%
Outcome 4	Interpret Maxwell's Equation	3	70%	65%
Outcome 5	Analyze and Interpret experimental data from experiments related to electrostatics	4	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	2	2	3	3			2			2	3	3	1
Outcome 2	3	3	3	3	3	2			2	2		2	3	3	2
Outcome 3	3	3	3	3	2	2		2	2	2		3	3	2	3
Outcome 4	3	3	3	3	1			2	2	2		3	3	3	2
Outcome 5	3	3	3	3	2			2	3	2		3	3	2	3
Average	3	3	2.8	2.8	2.2	2.3		2	2.2	2		2.6	3	2.6	2.2

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact hours	CLOs Addressed	Reference Used
Unit No.1	Magnetostatics	9		
	Introduction to Magneto-statics: Biot Savart Law	1	1	1,2
	Magnetic Field due current carrying wire and related problems	1	1,2	1,2
	Mag. Field due to current carrying loop and related problems	1	1,2	1,2
	Problems related to Magnetostatics	1	1,2	1,2
	Lorentz Force: Magnetic force on a moving charge particle.	1	1,2	1,2
	Magnetic Force on a current carrying wire.	1	1,2	1,2
	Introduction of Ampere's Law – comparison with Biot-savart Law	1	1,2	1,2
	Problems related to Ampere's Law	1	1,2	1,2
	Curl & Divergence of Magnetic Field, Magnetic vector potential.	1	1	1,2
Unit No. 2.	Magnetism and Magnetic properties	9		
	Introduction of Magnetic field (H), Magnetic flux (B) & Magnetization (M) and their inter-relation	1	1	1,2
	Magnetization and Susceptibility and magnetic permeability of magnetic materials	1	1, 2	1,2
	Classification of magnetic materials – Diamagnetic, Paramagnetic, Ferromagnetic. Similarities and differences.	1	1	1,2
	Discussion on Ferro and Anti-ferromagnetism: Hysteresis loop and Magnetic domains	1	1, 2	1,2
	Revisiting magnetic vector potential – free and bound charge & current	1	1	1,2
	The Magnetic Field Inside Matter – Magnetic field of a uniformly magnetized sphere.	1	1, 2	1,2
	Diamagnetic, paramagnetic, and ferromagnetic	1	1	1,2
	Ampere's law in Magnetized Materials.	1	1, 2	1,2
	Problems on magnetic vector potential	1	1, 2	1,2
Unit No. 3	Electromagnetic Induction	9		
	Steady current and Ohm's Law	1	1,3	1,2
	Electro-motive Force – introduction and understanding	1	1,3	1,2
	Motional Electro-motive Force	1	1,3	1,2
	Problems related to Electro-motive Force	1	2,3	
	Electromagnetic Induction – Faraday's Law & Lenz's Law.	1	1,2, 3	1,2
	The Induced Electric Field – related problems	1	2, 3	1,2
	Inductance: revisiting self and mutual inductance, transformers.	1	3	1,2
	Problems related to R-L, R-L AND R-L-C circuits	1	2,3	1,2
	Electromagnetic Energy in Magnetic Fields	1	1,3	1,2
	Maxwell's Equation	9		
	Generalized Ampere's Law – displacement current	1	1, 4	1,2,3,4,5

Unit No. 4	Introduction of four maxwell's equation – Integral form	1	1, 4	1,2,3,4,5
	Derivation of differential form of Maxwell's equation from Integral form.	1	1, 4	1,2,3,4,5
	Problems on Maxwell's Equation	1	2, 4	1,2,3,4,5
	Maxwell's equation in free space and in matter.	1	1, 4	1,2,3,4,5
	Loss of symmetry in MW Equation – absence of magnetic monopole	1	1, 4	1,2,3,4,5
	Boundary conditions related to MW Equations!	1	1, 4	1,2,3,4,5
	Problems on Boundary conditions of MW Equations	1	2, 4	1,2,3,4,5
	Physical Interpretation of MW Equations.	1	1, 4	1,2,3,4,5
Unit No. 5	Electromagnetic waves	9		
	Derivation of EM Wave equation from MW equation.	1	1, 4	1,2,3
	Propagation of EM Wave through free-space and medium.	1	1, 4	1,2,3
	Energy transfer due to EM Wave propagation – Poynting's Theorem & Poynting's Vector!	1	1, 2	1,2,3
	Problems related to Poynting's Theorem a	1	1, 2	1,2,3
	Reflection and Transmission of EM Wave – Normal Incidence	1	1, 2	1,2,3
	Polarization of EM Wave during transmission.	1	1, 2	1,2,3
	Problems on Reflection and Polarization of EM Wave	1	1, 2	1,2,3
	Absorption, dispersion and scattering of EM Wave – qualitative discussion	1	1, 2	1,2,3
	EM Wave spectra & applications of EM Waves – Fibre Optics, telecommunication, radar, microwave etc.	1	1, 2	1,2,3
Total contact hours (Theory)		45 Hours		

Course Unitization Plan: Laboratory

S. No.	Description of Experiments	Required Contact Hours	CLOs Addressed	References Used
1	To study the magnetic field along the axis of a current carrying circular loop and study the dependency of magnetic field on the diameter of coil.	6	1,5	1,2
2	To calculate the magnetic flux induced by the falling magnet as a function of the velocity of the magnet and measure induced voltage impulse as a function of the velocity of the magnet	6	1,5	1,2
3	To investigate the spatial distribution of magnetic field between coils and determine the spacing for uniform magnetic field	6	1,5	1,2
4	To demonstrate Dia-Para-Ferro magnetism in a given material using an inhomogeneous magnetic field	6	1,5	1,2
5	To study permeability curve of a given material.	6	1,5	1,2
Total Contact Hours		30 Hours		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50 %)								End Semester Exam (50 %)	
		CLA-1 (15 %)		CLA-2 (15 %)		CLA-3 (_ %)		Mid Term (20 %)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	40%	10%	20%	10%			40%		20%	10%
	Understand										
Level 2	Apply	20%	30%	40%	30%			60%		40%	30%
	Analyse										
Level 3	Evaluate										
	Create										
Total		60%	40%	60%	40%			100%		60%	40%

Recommended Resources

1. Purcell, E. (2017). Electricity and Magnetism (In SI Units): Berkeley Physics Course - Vol.2. New York, NY: McGraw Hill Education.
2. Griffiths, D. J. (2015). Introduction to Electrodynamics (4th ed.). New York, NY: Pearson.
3. Jackson, J. D. (2007). Classical Electrodynamics (3rd ed.). Hoboken, NJ: Wiley.
4. McKinley, G. (2011). Electromagnetics and Applications. MIT OpenCourseWare. URL: <https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-013-electromagnetics-and-applications-fall-2011/>
5. Acharya, B. S. (2021). Electromagnetic Theory. IIT Kharagpur. URL: <https://nptel.ac.in/courses/115/101/115101078/>

Other Resources

Introduction to Optics

Course Code	PHY 207	Course Category	CC				L	T	P	C
							3	0	1	4
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)						
Course Offering Department	Physics	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

1. Account for fundamental quantities for optics.
2. Identify, illustrate, and explain physical concepts in optics.
3. Describe and discuss technical applications of simple optical instruments.
4. Solve problems using suitable models, assumptions and approximations as well as be able to assess the results.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Explain the framework of geometrical and physical optics and their fields of manifestations	2	70%	65 %
Outcome 2	Employ the concepts of physical optics to the concepts of interference, diffraction and polarization	3	70 %	65 %
Outcome 3	Categorize the pattern formations through optical instruments by light waves	4	70%	65%
Outcome 4	Illustrate light-matter interactions and their applications	3	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	1	2					2	1		2	3	2	1
Outcome 2	3	3	2	2	1	1			2	2		3	3	3	1
Outcome 3	3	2	3	3	1	2		2	2	2		3	3	2	2
Outcome 4	3	3	2	3	2	2		1	2	2		2	3	2	2
Average	3	2.5	2	2.5	1.3	1.7		1.5	2	1.8		2.5	3	2.3	1.5

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	COs Addressed	References Used
Unit No. 1	Physical optics	9		
	The propagation of light and Rayleigh scattering	1	1	1, 2
	Laws of reflection and refraction	1	1	1, 2
	Fermat's principle	1	1	1, 2
	The electromagnetic approach of light propagation	1	1,2	1,2
	The Fresnel equations	1	1	1, 2
	Total internal reflection and evanescent waves	1	1	1, 2
	Optical properties of metals, Interaction of light and matter	1	1, 2	1, 2
	Stokes treatment of reflection and refraction	1	1, 2	1, 2
Photons and the laws of reflection and refraction	1	1,2	1, 2	
Unit No. 2	Geometrical optics	9		
	Prisms: dispersion and reflection properties	1	1	1, 2
	Planar and aspherical mirrors	1	1	1, 2
	Thick lenses and lens systems, Newton formula, lateral magnification	1	1, 3	1, 2
	Analytical ray tracing and development of Matrix methods	1	1, 2	1, 2
	Matrix analysis of system of two thin lenses, Unit and Nodal planes	1	1, 2	1, 2
	Matrix analysis of mirror systems	1	1, 2, 3	1, 2
	Monochromatic aberrations – Spherical aberration, Coma, Astigmatism, Field curvature, Distortion	1	1, 3	1, 2
	Chromatic aberrations, Thin achromatic doublets	1	1, 2, 3	1, 2
GRIN Systems and optical glasses	1	1, 2, 3	1, 2	
Unit No. 3	Interference of light	9		
	Coherence and Interference of Light Waves by Division of Wave Front	1	1,2	1, 2
	Interference pattern and intensity distribution	1	2, 3	1, 2
	Fresnel Biprism and Interference with white light, Displacement of fringes	1	2, 3	1, 2
	Interference by a plane parallel film illuminated by a plane wave and Cosine law	1	1,2, 3	1, 2
	High reflectivity from deposited thin film and reflection by a periodic structure	1	2, 3	1, 2
	Interference by a plane parallel film when illuminated by a point source	1	2, 3	1, 2
	Interference by a film with two nonparallel reflecting surfaces Color of Thin Films and Newton's Rings	1	2, 3	1, 2
	The Michelson Interferometer	1	2, 3	1, 2
	Multiple reflections from a plane parallel film, Fabry-Perot etalon and resolving power of Fabry-Perot interferometer	1	2, 3	1, 2
Unit No. 4	Diffraction of Light	9		
	Fraunhofer diffraction - single-slit diffraction pattern	1	1,2	1, 2
	Two-slit Fraunhofer diffraction pattern	1	2, 3	1, 2
	N-slit Fraunhofer diffraction pattern	1	2, 3	1, 2
	The Diffraction Grating and its resolution	1	2, 3	1, 2
	The Fresnel diffraction integral, and Fraunhofer approximation	1	1,2	1, 2
	Fraunhofer Diffraction by a Long Narrow Slit, Rectangular Aperture and Circular Aperture, Array of Identical Apertures and Spatial Frequency Filtering	1	2, 3	1, 2
	The free propagation of a spherical wave - Fresnel diffraction, half-period zones	1	2, 3	1, 2
	Diffraction at circular apertures, the Zone plate	1	2, 3	1, 2
Diffraction of a plane wave by a long narrow slit and transition to the Fraunhofer region	1	2, 3	1, 2	

Unit No. 5	Polarization of light	9		
	The Nature of Polarized Light, Types of polarization - plane, circular Elliptical Polarization	1	1,2	1,3,4
	Polarizers, Malus's Law of Polarization	1	2, 3	1,3,4
	Dichroism, Dichroic Crystals and Polaroid	1	2, 3	1,3,4
	Birefringence, Ordinary and extraordinary light,	1	2, 3	1,3,4
	Birefringent Crystals and Birefringent Polarizers	1	2, 3, 4	1,3,4
	Polarization by Reflection, The Fresnel Equations and Brewster's Law of Polarization	1	2, 3, 4	1,3,4
	Circular Polarizers, Half and full wave plates	1	2, 3	1,3,4
	Theory of Optical Activity and Polarimetry	1	2, 3, 4	1,3,4
	Induced Optical Effects—Optical Modulators, The Faraday Effect, The Kerr and Pockels Effects	1	2, 4	1,3,4
Total Contact Hours		45 hours		

Course Unitization Plan: Laboratory

S. No.	Description of Experiments	Required Contact Hours	CLOs Addressed	References Used
1	a) Determine angle of deviation (i) – deviation (D) of a given prism. b) To determine the Refractive Index of the Material of a given Prism using Sodium Light.	5	1,4	1,2
2	a) To determine the dispersion power of a prism material using Mercury light b) To Determine Cauchy's A and B constant with μ vs. $1/\lambda^2$ graph.	5	2	1,2
3	a) Determination of phase difference and wavelength using Michelson's interferometer b) Determination of Refractive index of glass plate using Michelson's interferometer	4	2,3	1,2
4	a) To observe the diffraction patterns by holes/single slit double slit with He-Ne laser source b) To observe the diffraction patterns by grating and obtain resolving power of the grating	4	2.4	1,2
5	To measure the light intensity of plane polarized light as a function of the analyzer position and verify Malus law (inverse square law)	4	3,4	1,2
6	To determine the specific rotation of cane sugar solution using Polarimeter	4	2,4	1,2
7	a) Experimental verification of Fresnel's equations for reflection of electromagnetic waves b) Experimental verification of Brewster's Law	4	3,4	1,2
Total contact hours (Experiments +Demo)		30		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50 %)								End Semester Exam (50 %)	
		CLA-1 (15 %)		CLA-2 (15 %)		CLA-3 (_ %)		Mid Term (20 %)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	40%	10%	20%	10%			40%		20%	10%
	Understand										
Level 2	Apply	20%	30%	40%	30%			60%		40%	30%
	Analyse										
Level 3	Evaluate										
	Create										
Total		60%	40%	60%	40%			100%		60%	40%

Recommended Resources

1. Mathur, B. K. (1967). Introduction to Geometrical and Physical Optics, 7th ed. Gopal Printing.
2. Jenkins, F., & White, H. (2017). Fundamentals of Optics, 4th ed. McGraw Hill Education.
3. Mazumdar, K. G., & Ghosh, B. (2010). A Textbook on Light, 3rd revised ed. Sreedhar Publication, India.
4. Hecht, E. (2017). Optics, 5th Global ed. Pearson Education Limited.

Other Resources

Atomic and Molecular Physics

Course Code	PHY 302	Course Category	CC				L	T	P	C
							3	0	1	4
Pre-Requisite Course(s)	PHY 213	Co-Requisite Course(s)	PHY 303 PHY 301L	Progressive Course(s)						
Course Offering Department	Physics	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

1. To understand the quantum mechanical phenomena at the atomic and molecular level.
2. To understand periodic table & origin of Atomic and Molecular Spectra.
3. To understand multi-electron atoms, LS & jj coupling in multi-electron atoms.
4. To learn spin orbit interactions and Zeeman effect.
5. To gain an insight of Electromagnetic wave, Photo-electric effect & X-ray emission.
6. To understand the lasing action in lasers

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Explain atomic structure and their stability	2	70%	65%
Outcome 2	Interpret atomic and molecular energy levels and the consequences of transitions between those levels	3	70%	65%
Outcome 3	Illustrate angular momenta coupling in multi-electron atoms	3	70%	65%
Outcome 4	Examine lasing mechanism in view of its origin and use cases	4	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	2	1						1		2	2		2
Outcome 2	3	3	2	2	1			1	2	2		3	3	2	2
Outcome 3	3	3	3	3		1		1	2	2		2	3	2	3
Outcome 4	3	2	2	3	2	1		2	2	2		2	3	3	2
Average	3.0	2.8	2.3	2.3	1.5	1.0		1.3	2.0	1.8		2.3	2.8	2.3	2.3

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	COs Addressed	References
Unit No. 1	Atomic structure	9		
	Thomson Model & Rutherford Scattering Exp	1	1	1, 2
	Rutherford Model: Stability of Atomic Model	1	1	1, 2
	Numerical problems on Rutherford scattering	1	1,2	1, 2
	Bohr Postulate & Bohr Atom	1	1	1, 2
	Energy levels and spectra	1	1,2	1, 2
	Numerical on energy level and spectra	1	1,2	1, 2
	Sommerfeld's Corrections: Elliptic Orbital	1	1	1, 2
	Relativistic correction of Sommerfeld's theory	1	1	1, 2
	Corresponding Principle and related problems	1	1,2	1, 2
Unit No. 2	Vector atom model	9		
	Vector atom model – Failure of BSW Model	1	1	1, 2
	Three dimension – three Q. Numbers	1	1	1, 2
	Concept of space quantization	1	1	1, 2
	Stern-Gerlach Experiment	1	1,2	1, 2
	Introduction of electron spin – failure of classical model. Rotational velocity of electronic surface.	1	1,2	1, 2
	Introduction of Spin Q. number	1	1,2	1, 2
	Numerical Problems on Four Quantum Numbers	1	2	1, 2
	Transition Rates and Selection Rules	1	2	1, 2
	Atomic Spectra (Qualitative)	1	2	1, 2
Unit No. 3	One and two valence electron systems	9		
	Pauli Exclusion Principle	1	1,2	2, 3
	Electronic Configuration	1	2	2, 3
	Periodic Tables	1	1	2, 3
	Spin-orbit coupling	1	3	2, 3
	Multi-electron Atom	1	3	2, 3
	L-S COUPLING – worked out examples	1	3	2, 3
	<i>j-j</i> COUPLING – worked out examples	1	3	2, 3
	Term Symbol in atomic physics	1	3	2, 3
	Normal and Anomalous Zeeman Effect	1	3	2, 3
Unit No. 4	Atomic and Molecular spectroscopy	9		
	Electromagnetic Wave: Property and Propagation	1	1	2, 3
	EM Wave Spectra and Microwave	1	1	2, 3
	Photo-electric effect: concept of work-function	1	2	2, 3
	X-ray emission spectra: Inverse of PE Effect	1	2	2, 3
	Bremsstrahlung effect & Origin of Sharp peaks: Duane and Hunt's Rule	1	2	2, 3

	Mosley's law and Quantization of Atomic Spectra	1	2	2, 3
	Augur Effect and X-ray Diffraction	1	2	2, 3
	Molecular Bond and Molecular Orbital Pairing	1	2,3	2, 3
	Molecular Spectroscopy: Rotational and Vibrational Spectra	1	2	2, 3
Unit No. 5	LASERS	9	6	
	Basics and Development of LASER	1	2,4	2, 3
	Characteristics of LASER	1	4	2, 3
	How to make a LASER: Transition between two states	1	2,4	2, 3
	Einstein coefficient & thermal equilibrium	1	4	2, 3
	Optical Gain Medium & Population Inversion in Two State system	1	4	2, 3
	Three state energy system and Lasing mechanism	1	2,4	2, 3
	Types of LASERS: Continuous and Pulsed Laser. Gas Laser, SSL, FEL etc.	1	4	2, 3
	Classification of LASER and Safety of LASER Use	1	4	2, 3
	Application of LASER in Industry and Research: Brief discussion of Pulsed Laser Deposition process	1	4	2, 3
Total Contact Hours		45		

Course Unitization Plan: Laboratory

S. No.	Description of experiments	Required Contact Hours	COs Addressed	References
1	To determine the wavelengths of Balmer series in the visible region from atomic emission	4	1,2	1, 2
2	To determine the Rydberg constant using visible spectra of He or Hg spectra	4	1,2	1, 2
3	To record the modification of Franck-Hertz characteristic curve varying the gate voltage	4	1	1,2
4	Measuring the speed of sound, by measuring the Bragg angle using an acoustic-optics modulator and laser diffraction.	6	1,4	1, 2
5	To determine beam divergence and M-parameter of a He-Ne laser beam and compare it with commercial laser pointer beam.	6	4	1, 2
6	To determine particle size of a given powders using wave optics method	6	2	1, 2
Total contact hours		30		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50 %)								End Semester Exam (50 %)	
		CLA-1 (15 %)		CLA-2 (15 %)		CLA-3 (_ %)		Mid Term (20 %)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	40%	10%	20%	10%			40%		20%	10%
	Understand										
Level 2	Apply	20%	30%	40%	30%			60%		40%	30%
	Analyse										
Level 3	Evaluate										
	Create										
Total		60%	40%	60%	40%			100%		60%	40%

Recommended Resources

1. Eisberg, R., & Resnick, R. (2006). Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles, 2nd ed. Wiley..
2. Besier, A., Choudhury, S. R., & Mahajan, S. (2015). Concepts of Modern Physics, 7th ed. McGraw Higher Ed.
3. Rajam, J. M. (2010). Atomic Physics, Revised ed. S Chand Publication

Other Resources

1. Brooks, R. L. (2013). The Fundamentals of Atomic and Molecular Physics, 1st ed. Springer Verlag New York.
2. Bransden, B. H., & Joachain, C. J. (Year). Physics of Atoms and Molecules, 2nd ed. Pearson Education India.

Statistical Physics

Course Code	PHY 301	Course Category	CC				L	T	P	C
							3	0	1	4
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)						
Course Offering Department	Physics	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

1. Familiarize about the elementary concepts of random walk problem, Brownian motion, probability distribution.
2. Introducing the basic postulates of statistical physics, concept of statistical ensemble, density of states, reversibility, and irreversibility.
3. Concept of thermal equilibrium, entropy, thermodynamics laws, partition function.
4. Familiarize with equipartition theorem, different kinds of ensemble and its applications.
5. Introducing quantum statistics, Maxwell-Boltzmann, Bose-Einstein and Fermi Dirac statistics and Bose – Einstein condensation.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Describe the elementary concept of probability and basic postulates of statistical physics	2	70%	65%
Outcome 2	Interpret the postulates of statistical physics in the context of ensemble theory and reversibility, and irreversibility of thermodynamic processes	2	70%	65%
Outcome 3	Employ the concept of probability, equilibrium, entropy, and partition functions for the laws of thermodynamics and equipartition theorem	3	70%	65%
Outcome 4	Interpret the quantum mechanical effects on statistics of many particle systems	3	70%	65%
Outcome 5	Synthesize theoretical and computational methods to evaluate a statistical physics system and present conclusions	5	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	2	3	1							2	3	3	3
Outcome 2	3	3	3	2	2		2	2	1			1	2		3
Outcome 3	3	3	2	3								2	2		3
Outcome 4	3	2	3	1			2	2	2			3	3		3
Outcome 5	3	3	3	3	3	2	2	3	2			2	3	3	3
Average	3	2.8	2.6	2.4	3	2	2	2.5	2			2	2.6	3	3

Course Unitization Plan

Unit No.	Description of Topic	Required Contact hours	CLOs Addressed	Reference Used
Unit 1	Elementary statistical concepts and examples			
	Basic concepts of probability distributions	1	1	1,2,3
	Continuous probability distributions	1	1	1,2,3
	Binomial probability distribution	1	1	1,2,3
	Gaussian probability distribution	1	1	1,2,3
	Calculation of mean values	1	1,3	1,2,3
	Review of problems on probability distributions	1	1,3	1,2,3
	Simple random walk problem in one dimension	1	1	1,2,3
	Examples of Brownian motion	1	1	1,2,3
	Review and problems on random walks and probability distributions	1	1,3	1,2,3
Unit 2	Statistical descriptions of systems of particles			
	Specification of the state of a statistical system	1	2	1,2,3
	Statistical ensemble - basic postulates and probability calculations	1	1,2	1,2,3
	Review and problems on statistical ensembles	1	2	1,2,3
	Density of states of statistical ensembles	1	2	1,2,3
	Problems on density of states	1	2	1,2,3
	Thermal and mechanical interaction between macroscopic systems.	1	2	1,2,3
	Discussion on constraints of thermal and mechanical interaction between macroscopic systems.	1	2	1,2,3
	Discussion on equilibrium, non-equilibrium, reversibility, and irreversibility in thermodynamic systems	1	2	1,2,3
	Review and problems on thermal and mechanical interaction, its constraints and Problems & examples on Equilibrium/non-equilibrium and reversibility /irreversibility of thermodynamic systems.	1	2	1,2,3
Unit 3	Statistics of Macroscopic systems			
	Distribution of energy between macroscopic systems	1	3	1,2,3
	Discussion on the approach to thermal equilibrium	1	3	1,2,3
	Examples and problems on thermal equilibrium	1	2,3	1,2,3
	Temperature, mean energy, and mean pressure of an ideal gas	1	3	1,2,3
	Introduction of the concept of entropy & discussion of second and third law of thermodynamics involving entropy	1	3	1,2,3
	Review of all thermodynamic laws and basic statistical relations & related problems.	1	3	1,2,3
	The partition function and its properties – relevant problems	1	3	1,2,3
	Calculation of thermodynamic quantities for an ideal monatomic gas – relevant problems	1	3	1,2,3
	Discussion of the Gibbs paradox involving relevant examples.	1	3	1,2,3
Unit 4	Equipartition theorem			
	Introduction of various thermodynamics systems – Isolated, adiabatic, Isobaric, Isochoric etc.	1	2,3	1,2,3
	Examples and problems on important thermodynamic systems	1	3	1,2,3
	Discussion on Canonical ensemble – comparison with micro-canonical ensemble.	1	2,3	1,2,3
	Applications, examples and problems on the canonical ensemble,	1	2	1,2,3
	Maxwell distribution and the Equipartition theorem,	1	3	1,2,3
	Simple applications of the Equipartition theorem	1	3	1,2,3
	The grand canonical ensemble – comparison with micro-canonical and canonical ensemble	1	2,3	1,2,3
	Introduction of the chemical potential	1	3	1,2,3
	Review and problems on Equipartition theorem and canonical and grand-canonical ensemble.	1	3	1,2,3

Unit No.	Description of Topic	Required Contact hours	CLOs Addressed	Reference Used
Unit 5	Quantum Statistics			
	Introduction of concept of Identical particles and symmetry requirements	1	1,4	1,2,3
	Discussion on quantum states of a single particle	1	4	1,2,3
	Introduction of Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics.	1	1,4	1,2,3
	Equation of states for Bose and Fermi gases	1	4	1,2,3
	$PV = (2/3) E$ – the ideal gas in the classical limit	1	4	1,2,3
	Evaluation of the partition function.	1	3,4	1,2,3
	partition function of ideal monatomic Boltzmann gas	1	3,4	1,2,3
	Simple ideas for Bose- Einstein condensation and recent observations,	1	4	1,2,3
	Problems and examples on Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics & partition function	1	1,4	1,2,3
Total		45		

Course Unitization Plan Project

Unit No.	Description of Topic	Required Contact hours	CLOs Addressed	Reference Used
Unit 1	Refinement of Idea	3	1,2,3,4	As recommended by the Advisor
Unit 2	Study the Mathematical model	10	1,2,3,4	
	Set up and investigate the mathematical models for the considered problem			
Unit 3	Conduct the theoretical analysis and extract the results	10	5	
	Perform the analytical work to solve the model and interpret the findings.			
Unit 4	Make a concise report of the work and prepare a presentation of the findings	7	5	

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50 %)								End Semester Exam (50 %)	
		CLA-1 (15 %)		CLA-2 (15 %)		CLA-3 (_ %)		Mid Term (20 %)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	60%		40%				50%		30%	50%
	Understand										
Level 2	Apply	40%		60%				50%		70%	40%
	Analyse										
Level 3	Evaluate										10%
	Create										
Total		100%		100%				100%		100%	100%

Recommended Resources

1. Statistical Physics (In SI Units): Berkeley Physics Course - Vol.5, F Reif, 1 edition, 2017, McGraw Hill Education.
2. Statistical Physics F. Mandl, 2nd Edition, 2003, Wiley.
3. Statistical Mechanics, R. K. Pathria, 2nd Edition.

Other Resources

Course Designers

Analog and Digital Electronics

Course Code	PHY 303	Course Category	CC				L	T	P	C
							3	0	1	4
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)						
Course Offering Department	Physics	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

1. Understanding electronic systems, helping students comprehend the behaviour of continuous signal circuits and components.
2. Equips students with the skills to design, analyse, and troubleshoot systems such as audio systems, sensors, and control systems.
3. Provides the foundational knowledge required for more advanced courses in electronics, such as RF (Radio Frequency) and mixed-signal integrated circuit design.
4. Students learn about circuit design principles, analysing the behaviour of amplifiers, oscillators, and other analogy building blocks, enabling them to create functional circuits.
5. Students apply their learning to create practical digital systems, enhancing their project management and implementation skills

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Summarize the role of passive and active components like resistors, capacitors, inductors, diodes, and transistors in analog circuits	2	70%	65%
Outcome 2	Relate theoretical knowledge with practical skills through laboratory sessions involving analog circuits.	3	70%	65%
Outcome 3	Conduct testing for verification of digital circuits, including simulation, timing analysis, and fault detection.	3	70%	65%
Outcome 4	Examine digital systems through practical projects	4	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Life Long Learning	PSO 1	PSO 2
Outcome 1	3	2	2	2	2	3		2			2	3	3	2
Outcome 2	3	3	2	3	3	3		1	2	2	3	3	3	2
Outcome 3	3	3	3	3	3	3		2	3	2	3	3	3	2
Outcome 4	3	3	3	3	3	3		2	3	2	3	3	3	2
Average	3	2.8	2.5	2.8	2.8	3		1.7	2.5	2	2.8	3	3	2

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact hours	CLOs Addressed	Reference Used
Unit No. I	Semiconductor Fundamentals	9	1, 2	1
	Types of solids	1	1	1
	Semiconducting materials: Introduction	1	1	1
	Semiconducting materials: Types	1	1	1
	Conduction energy band valance energy band	1	1	1
	Origin of band gap, Doping of semiconductor	1	1	1
	<i>n</i> and <i>p-type</i> semiconductor and their carrier concentrations, energy levels calculations	1	1,2	1
	Carrier diffusions in semiconductors	1	1,2	1
	Electric field-induced carrier drift in semiconductors	1	1,2	1
	Ernestine's equations in semiconductors	1	1	1
Unit No. II	Analog Electronics	9		
	P-n junction diodes and equivalent circuit	1	1, 2, 3	2, 3
	Zener diodes and their applications	1	1, 2, 3	2, 3
	Clipping and clamping application	1	1, 2, 3	2, 3
	Bipolar junction transistor, types	1	1, 2, 3	2, 3
	Symbols and basic configurations (Common Base, Common Emitter & Common C ollector)	1	1, 2, 3	2, 3
	Definition of alpha, beta and their relations	1	1, 2, 3	2, 3
	Input, output, and transfer characteristics of CE and CB configurations	1	1, 2, 3	2, 3
	AC and DC load lines	1	1, 2, 3	2, 3
	operating point (Q point)	1	1, 2, 3	2, 3
Unit No. III	Operational Amplifiers and Oscillators	9		
	Positive and negative feedback, four types of negative feedback	1	1, 2, 3	2, 3
	Operational amplifier: IC 741- Block diagram, Characteristics: ideal and practical	1	1, 2, 3	2, 3
	Concept of virtual ground	1	1, 2, 3	2, 3
	Inverting and non-inverting operational amplifiers with the concept of gain	1	1, 2, 3	2, 3
	Operational amplifier as an adder, subtracted, and other examples	1	1, 2, 3	2, 3
	Oscillators: concept of positive and negative feedback	1	1, 2, 3	2, 3
	Barkhausein criteria, Phase shift oscillator, and Wien bridge oscillator (Derivation for frequency and feedback factor for both oscillators)	1	1, 2, 3	2, 3
	Power amplifiers	1	1, 2, 3	2, 3
	Class A / B / C and operators	1	1, 2, 3	2, 3
Unit No. IV	Power Supplies	9		
	Half wave, Full wave rectifier	1	2,3	2
	Ripple factor	1	2,3	2
	Bridge rectifier	1	2,3	2
	Capacitor filter	1	2,3	2
	Difference between regulated and unregulated power supply	1	2,3	2
	Definition of Line and Load regulation	1	1,2,3	2
	Series and Shunt regulators- Block diagram and circuit of regulated power supply using discrete components	1	2,3	2
	Simple current limiting circuit	1	2,3	2
	Design of a regulated DC power supply	1	2,3	2
Unit No. V	Digital Electronics	9		
	Number systems: Binary, Binary coded decimal (BCD), Octal, Hexadecimal	1	3, 4	2, 4

	Addition and subtraction of binary numbers and binary fractions	1	3, 4	2, 4
	Basic logic gates: OR, AND, NOT	1	3, 4	2, 4
	Derived gates: NOR, NAND, EXOR, EXNOR with symbols and truth tables	1	3, 4	2, 4
	Boolean algebra	1	3, 4	2, 4
	Boolean Equations	1	3, 4	2, 4
	De Morgan's theorems and its verification	1	3, 4	2, 4
	Introduction to ROM, RAM, and PROM	1	3, 4	2, 4
	Introduction to EPROM, and EEPROM	1	3, 4	4
	Total Contact Hours	45		

Course Unitization Plan: Laboratory

S.No.	Description of Experiments	Required Contact Hours	CLOs Addressed	References Used
1	To determine the forward and reverse characteristics of the p-n junction. To determine the Load line of the junction diode.	2	2, 4	2
2	To study the characteristics of a Zener Diode and to study its use as a Voltage Regulator	2	2, 4	2
3	To study Full-wave Rectifier and investigate the effect of C, L and π filters	4	2, 4	2
4	To study Bridge Rectifier and investigate the effect of C, L and π filters	4	2, 4	2
5	To study the CE Characteristics of a Transistor and finding load line and Q-factor	6	2, 4	2
6	To design an Inverting and Non-Inverting Amplifier of given gain using Op-amp	4	2, 4	2
7	To study the working of op-amp as adder, subtractor and comparator	4	2, 4	2
8	To design and study a precision Differential Amplifier of given I/O specification using Op-amp 741.	4	2, 4	2
	Total contact hours (Experiments + Demo + Extra class)	30 Hours		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50 %)								End Semester Exam (50 %)	
		CLA-1 (15 %)		CLA-2 (15 %)		CLA-3 (___ %)		Mid Term (20 %)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	40%	10%	20%	10%			40%		20%	10%
	Understand										
Level 2	Apply	20%	30%	40%	30%			60%		40%	30%
	Analyse										
Level 3	Evaluate										
	Create										
Total		60%	40%	60%	40%			100%		60%	40%

Recommended Resources

1. Neamen, D., & Biswas, D. (2017). Semiconductor Physics and Devices. 4th edition, New York: McGraw Hill Education.
2. Boylestad, R. L., & Nashelsky, L. (2015). Electronic Devices and Circuit Theory. 11th edition, Boston: Pearson.
3. Rajasekaran, K. S. (2020). Analog Electronics. NPTEL. URL: <https://nptel.ac.in/courses/108/106/108106145/>
4. Freeman, D. (2008). Introduction to Electronics. MIT OpenCourseWare. URL: <https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-070-introduction-to-electronics-spring-2008/>

Other Resources

Course Designers

Special Theory of Relativity

Course Code	PHY 304	Course Category	CC				L	T	P	C
							3	1	0	4
Pre-Requisite Course(s)	Mechanics	Co-Requisite Course(s)		Progressive Course(s)						
Course Offering Department	Physics	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

1. Review Newtonian mechanics and understand the need for the Theory of Relativity.
2. Learn the meaning and significance of the postulate of Special Relativity through different examples.
3. Apply the Lorentz transformation rules to comprehend the concept of simultaneity and Causality principle.
4. Understand the interconnection of Electric and Magnetic fields, and the invariance of Maxwell's equations.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Describe Lorentz transformations from the Postulates of Relativity.	2	70%	65%
Outcome 2	Illustrate the effect of Lorentz Transformations on Mass, Length and Velocity measurements and the origin of magnetic fields	3	70%	65%
Outcome 3	Interpret the mass energy equivalence and relativistic mass of zero rest mass particles.	3	70%	65%
Outcome 4	Examine the concept of relativity of simultaneity in analysing Minkowski space-time diagram	4	70%	65%
Outcome 5	Investigate relativistic effects on classical electrodynamics	4	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	3	3	3			1	2	2		3	2		1	
Outcome 2	3	3	3	3	2		1	2			3	3	1	2	
Outcome 3	3	3	3	3	2		2	3	1		3	3	1	2	
Outcome 4	1	3	3	3	3		2	3	2		3	3	2	2	
Outcome 5	2	3	3	3			2	3	3		3	2		1	
Average	2.2	3	3.0	3	2.3		2.0	1.6	2.6	2.0	3	2.6	1.3	1.6	

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact hours	CLOs Addressed	Reference Used
Unit No. 1	INTRODUCTION TO RELATIVITY	12	1	1,2
	Frame of Reference	1	1	1,2
	Universality of Newton's second law in all inertial frames	1	1	1,2
	Absolute Frame and Ether Hypothesis	1	1	1,2
	Michelson Morley Experiment	1	1	1,2
	Attempts to preserve the concept of Ether frame	1	1	1,2
	Postulates of Special Theory of Relativity	1	1	1,2
	Concept of transformation	1	1	1,2
	Galilean Transformation	1	1	1,2
	Simultaneity of two events in different inertial frames of reference and its frame dependence	1	1	1,2
	Tutorial: Inertial frames	1	1	1,2
	Tutorial: Challenges to Galilean relativity	1	1	1,2
	Tutorial: Postulates of relativity	1	1	1,2
Unit No. 2	RELATIVISTIC KINEMATICS	12		
	Clock Synchronization in an Inertial Frame	1	2,3	1,2
	Lorentz Transformation.	1	2,3	1,2
	Length Contraction	1	2,3	1,2
	Time dilation	1	2,3	1,2
	Examples of Length Contraction and Time dilation	1	2,3	1,2
	Concept of Simultaneity	1	2,3	1,2
	Examples on Simultaneity	1	2,3	1,2
	Relativistic Addition of Velocities	1	2,3	1,2
	Applications of Velocity Addition Theorem	1	2,3	1,2
	Tutorial: Aberrations	1	2,3	1,2
	Tutorial: Relativistic Doppler Effects	1	2,3	1,2
	Tutorial: Simultaneity	1	2,3	1,2
Unit No. 3	RELATIVISTIC DYNAMICS	12		
	Concept of Causality	1	2,3	1,2
	Order of Events	1	2,3	1,2
	Time like and Space Like intervals	1	2,3	1,2
	Need to redefine Momentum	1	2,3	1,2
	Minkowski Space and Four Vectors	1	2,3	1,2
	Velocity and Momentum-Energy Four Vector	1	2,3	1,2
	Proper Length and Proper time interval	1	2,3	1,2
	Relativistic velocity and momentum	1	2,3	1,2
	Alternative Views of Mass in Relativity	1	2,3	1,2
	Tutorial: Causality	1	2,3	1,2
	Tutorial: 4-vectors	1	2,3	1,2
	Tutorial: Intervals in relativity	1	2,3	1,2
Unit No. 4	MASS ENERGY EQUIVALENCE	12		
	Mass and Energy relationship in Newtonian mechanics	1	2,3	1,2
	New relationship between Mass, Energy and Momentum	1	2,3	1,2
	Relativistic dynamics of a single particle	1	2,3	1,2
	Frame independence of total Energy and Relativistic Mass	1	2,3	1,2
	Equivalence of Mass and Energy	1	2,3	1,2
	Zero mass particles	1	2,3	1,2
	Tutorial: Transformation properties of Momentum, Energy, Mass and Force	1	2,3	1,2,3
	Space-time diagrams and Light cone	1	4	1,2,3
	Present, Absolute Past and Absolute Future	1	4	1,2,3
	Tutorial: Simultaneity using space-time diagrams	1	4	1,2,3
	Tutorial: Contraction/dilation using space-time diagrams	1	4	1,2,3
	Twin Paradox	1	4	1,2,3

Unit No. 5	RELATIVITY AND ELECTROMAGNETISM	12		
	Interdependence of Electric and Magnetic Fields	1	2,5	1,2,3
	Transformation of E and B fields	1	2,5	1,2,3
	The field of a Uniformly moving point charge	1	5	1,2,3
	Forces between moving charges	1	2,5	1,2,3
	Invariance of Maxwell's equation	1	5	1,2,3
	Four Potential	1	5	1,2,3
	Energy-Momentum Tensor	1	2,5	1,2,3
	Four-Dimensional form of Maxwell's equations	1	5	1,2,3
	Lagrangian formulation of Electrodynamics	1	5	1,2,3
	Tutorial: origin of magnetic field	1	5	1,2,3
	Tutorial: Four potential	1	5	1,2,3
Tutorial: Energy-momentum tensor	1	5	1,2,3	
Total Contact Hours		60		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50 %)								End Semester Exam (50 %)	
		CLA-1 (15 %)		CLA-2 (15 %)		CLA-3 (___%)		Mid Term (20 %)		Th	Prac
		Th	Prac	Th	Prac	Th	Prac	Th	Prac		
Level 1	Remember	60%		40%				40%		30%	
	Understand										
Level 2	Apply	40%		60%			60%		70%		
	Analyse										
Level 3	Evaluate										
	Create										
Total		100%		100%				100%		100%	

Recommended Resources

1. Resnick, R. (1968). Introduction to Special Relativity. New York, NY: Wiley.
2. French, A. P. (1968). Special Relativity. New York, NY: Norton.
3. Einstein, A. (1995). Relativity: The Special and the General Theory. New York, NY: Three Rivers Press/Random House.

Other Resources

Course Designers

CO-CURRICULAR ACTIVITIES

Course Code	VAC 103	Course Category	VAC				L	T	P	C
							0	0	2	2
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)						
Course Offering Department	SA	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

1. Develop essential skills, including leadership, communication, and teamwork, among students.
2. Offer opportunities for students to apply academic concepts in practical, real-world scenarios.
3. Promote self-exploration, confidence-building, and social responsibility.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Demonstrate confidence in leading group activities, communicate clearly, and collaborate effectively with diverse teams.	2	80%	75%
Outcome 2	Apply theories to practical tasks by solving problems and adapting concepts to real-life situations through cocurricular activities	2	80%	70%
Outcome 3	Develop new experiences with an open approach through guided reflection to assess personal growth, skills, and learning for holistic development.	3	80%	70%

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments 100%			
		CLA-1 25%	CLA-2 25%	CLA-3 25%	CLA-4 25%
Level 1	Remember				
	Understand				
Level 2	Apply	15%	15%	15%	15%
	Analyse				
Level 3	Evaluate	10%	10%	10%	10%
	Create				
Total		25%	25%	25%	25%

COMMUNITY SERVICE AND SOCIAL RESPONSIBILITY

Course Code	VAC 104	Course Category	VAC		L	T	P	C
					0	0	2	2
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)				
Course Offering Department	CEL	Professional / Licensing Standards						

Course Objectives / Course Learning Rationales (CLRs)

1. Encourage initiatives that address local needs, foster self-sufficiency, and promote environmental sustainability within the community.
2. Equip participants with a deeper understanding of social issues and a sense of responsibility towards marginalized communities.
3. Inspire active participation in community service programs and foster a culture of giving back among individuals and organizations.
4. Develop and implement programs that contribute to skill development, economic empowerment, and equal opportunities for underprivileged sections of society.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Develop effective strategies for identifying and addressing community needs.	3	80%	80%
Outcome 2	Demonstrate empathy and cultural sensitivity when engaging with diverse community groups.	4	80%	75%
Outcome 3	Implement sustainable solutions and evaluate their impact on social well-being.	5	90%	85%
Outcome 4	Collaborate effectively within teams to design and lead community service projects.	6	90%	80%

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments 50%				End Semester Exam 50%
		CLA-1 20%	Mid-1 20%	CLA-2 20%	CLA-3 20%	
Level 1	Remember	10%	10%			20%
	Understand					
Level 2	Apply		10%	10%		20%
	Analyse					
Level 3	Evaluate				10%	10%
	Create					
Total		10%	20%	10%	10%	50%

Solid State Physics

Course Code	PHY 307	Course Category	CC				L	T	P	C
							3	0	1	4
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)						
Course Offering Department	Physics	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

1. To understand the basic knowledge on crystal structures and crystal systems.
2. To acquire the knowledge on the classification solids into conductors, semiconductors and insulators.
3. To acquire knowledge on lattice vibrations, thermal properties and electric conductivity of solids.
4. To comprehend the concepts of dielectric and magnetic properties of solids.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Describe crystal structure, bonding in solids, lattice vibrations, band theory of solids and electronic structure of solids	1	70%	65%
Outcome 2	Explain the electronic, thermal, and magnetic properties of solid materials using band theory	2	70%	65%
Outcome 3	Develop skills to solve problems related to the electronic, thermal, and magnetic properties of solids.	3	70%	65%
Outcome 4	Interpret data from experiments such as the Hall effect and X-ray diffraction to determine the electronic, thermal, and magnetic properties of materials.	4	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	1	1	1	1							2	3	1	1
Outcome 2	3	2	1	1	1			1	1	1		3	3	1	1
Outcome 3	3	3	2	2	2			2	2	2		3	3	2	1
Outcome 4	3	3	3	2	3	3		1	1	2		3	3	3	2
Average	3	2.3	1.8	1.5	1.8	3.0		1.3	1.3	1.7		2.8	3.0	1.8	1.3

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact hours	CLOs Addressed	References
Unit No. 1	Crystallography	9		
	Crystalline and amorphous solids, Lattice, Basis, Primitive unit cell.	1	1	1,2
	Symmetry operations, Different types of lattices-2D and 3D (Bravais lattices), Crystal systems	1	1	1,2
	SC, BCC, FCC, HCP structures, Packing fraction	1	1	1,2
	Miller indices, Inter-planer distances	1	1	1,2
	Crystal structures- NaCl, Diamond, CsCl, ZnS	1	1	1,2
	Reciprocal lattice	1	1	1,2
	Bragg's law	1	1	1,2
	Debye Scherrer method,	1	1,2	1,2
	Ionic, covalent, molecular and metallic binding in crystalline solids, Cohesive energies of ionic crystals	1	1,2	1,2
Unit No. 2	Lattice Vibrations and specific heat of solids	9		
	Specific heats of solids	1	1	1,2,3
	Classical theory of Specific heat, Dulong-Petit Law	1	1	1,2,3
	Breakdown of classical theory, Einstein theory of specific heat	1	1,2	1,2,3
	Debye theory of specific heat, T^3 law	1	1,2	1,2,3
	Lattice vibrations. Concept of phonons.	1	1,2	1,2,3
	One dimensional monoatomic lattice	1	1	1,2,3
	Phase velocity and group velocity	1	1,2	1,2,3
	Phonon vibration of diatomic linear lattice	1	1,2	1,2,3
	Qualitative description of the phonon spectrum in solids. Acoustical and optical phonons	1	1,2	1,2,3
Unit No. 3	Free electron theory of metals	9		
	Classical theory of free electrons, Drude-Lorentz theory	1	1	1,2,4
	Temperature dependent electrical resistivity of metals	1	1,2	1,2,4
	Thermal conductivity of metals	1	1,2	1,2,4
	Wiedemann-Frank's law, Failure of classical theory	1	1	1,2,4
	Free electron gas in one dimension	1	1,2	1,2,4
	Fermi-Dirac distribution function	1	1,2	1,2,4
	Free-electron theory of metals	1	1	1,2,4
	Heat capacity of the electron gas	1	1	1,2,4
	Thermionic emission	1	1	1,2,4
Unit No. 4	Band theory of solids, Semiconductors	9		
	Failure of Free electron theory of metals	1	1,2	1,2,3
	Nearly free electron model, Bloch theorem	1	1	1,2,3
	Kronig Penny model	1	1	1,2,3
	Brillouin zones, Concept of effective mass	1	1,2	1,2,3
	Distinction between metal, semiconductor, and insulator	1	1,2	1,2,3
	Band theory of solids	1	2	1,2,3
	Temperature dependent resistivity of metals, semiconductors, and insulators	1	1,2	1,2,3
	Intrinsic and extrinsic semiconductors P-type and N-type semiconductors	1	1,2	1,2,3
	Hall effect in semiconductors	1	1	1,2,3

Unit No. 5	Dielectric and Magnetic properties of materials	9		
	Polarization	1	1	1,2,3,4
	Local electric field at an atom	1	1,2	1,2,3,4
	Depolarization field, Dielectric susceptibility and polarizability, Dielectric constant	1	1,2	1,2,3,4
	Clausius-Mosotti equation	1	1	1,2,3,4
	Diamagnetic, paramagnetic, Ferromagnetic and ferrimagnetic materials	1	1,2	1,2,3,4
	Classical Langevin's theory of diamagnetism and paramagnetism, Curie law	1	1,2	1,2,3,4
	Weiss theory of ferromagnetism and magnetic domains	1	1,2	1,2,3,4
	Discussion on B-H curve, Magnetic hysteresis, and energy loss	1	2	1,2,3,4
	Soft and hard magnetic materials	1	2	1,2,3,4
Total Contact Hours		45		

Course Unitization Plan: Laboratory

S. No.	Description of Experiments	Required Contact hours	CLOs Addressed	References
1.	Determine lattice parameter of crystals using X-ray diffractometer	6	1,4	5
2.	Measurement of resistivity of a semiconductor by Four-probe method and determination of Energy Band Gap	3	1,4	5
3.	To determine the type of charge carrier, carrier density and Hall coefficient of a given semiconductor	3	1,4	5
4.	a) To measure the photo-current as a function of the irradiance at constant voltage b) Current-voltage and current-load characteristics of a solar cell as a function of the irradiance	6	1,4	5
5.	Study optical absorption of liquid samples using UV-VIS spectrometer	6	1,4	5
6.	To study optical absorption of different nanoparticles and obtain their plasmonic peaks	3	1,4	5
7.	To measure the ionic conductivity of ionic conductors as a function of temperature using impedance spectroscopy.	3	1,4	5
Total Contact Hours		30		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50 %)								End Semester Exam (50 %)	
		CLA-1 (15 %)		CLA-2 (15 %)		CLA-3 (_ %)		Mid Term (20 %)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	40%	10%	20%	10%			40%		20%	10%
	Understand										
Level 2	Apply	20%	30%	40%	30%			60%		40%	30%
	Analyse										
Level 3	Evaluate										
	Create										
Total		60%	40%	60%	40%			100%		60%	40%

Recommended Resources

1. Kittel, C. (2004). Introduction to Solid State Physics, 8th ed. Hoboken, NJ: John Wiley & Sons.
2. Omar, M. A. (2015). Elementary Solid-State Physics, Revised ed. New York, NY: Pearson.
3. MIT OpenCourseWare. (2006). Physics of Solids I. Retrieved from <https://ocw.mit.edu/courses/8-231-physics-of-solids-i-fall-2006/>
4. National Programme on Technology Enhanced Learning (NPTEL). (n.d.). Solid State Physics. Retrieved from <https://nptel.ac.in/courses/115/104/115104109/>
5. Department of Physics, SRM University AP. Engineering Physics lab manuals. Retrieved from Engineering Physics Lab (FIC102) <https://srmap.edu.in/seas/physics-teaching-lab/>

Other Resources

Nuclear and Particle Physics

Course Code	PHY 305	Course Category	CC				L	T	P	C
							3	1	0	4
Pre-Requisite Course(s)	PHY 303, PHY 302	Co-Requisite Course(s)		Progressive Course(s)						
Course Offering Department	Physics	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

1. To understand the basic properties of Nucleus and Nuclear Models
2. To discuss Nuclear Radioactivity, its classifications and applications
3. To review fundamental forces of Nature and discuss the physics of elementary particles
4. To introduce Nuclear Reactions, Reactors and Particle Accelerators

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Explain the properties of a Nucleus and discuss nuclear models.	2	70%	65%
Outcome 2	Illustrate the origin of stability of nucleus, radioactive decays, and interpret the decay profile of a given nucleus.	3	70%	65%
Outcome 3	Categorize elementary particles based on their quantum numbers and analyze the rates of physical processes involving these elementary particles.	4	70%	65%
Outcome 4	Examine nuclear reactions and analyze the working principle of nuclear detectors and particle accelerators.	4	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	3	1	2	1						2	2	2	1
Outcome 2	3	3	3	3	3	1	2	1	2			2	2	2	2
Outcome 3	3	3	3	3	3	2	1	2	2	2		2	3		3
Outcome 4	3	3	3	3	3	2	3	1	2	2		2	3	2	3
Average	2.8	3.0	2.8	2.6	2.8	1.8	2.0	1.5	2.3	2.0		2.0	2.4	2.3	2.4

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLO's Addressed	References
Unit No. 1	General properties of nuclei	12		
	Discovery of the nucleus, Composition, Charge, size, density of nucleus	1	1	1, 2, 4
	Nuclear Spin and Parity, Isobars, isotopes and isotones	1	1	1, 2, 4
	Mass defect, Binding energy, Packing fraction	1	1,2	1, 2, 4
	Tutorial – 1 (Isospin formalism)	1	1	1, 2, 4
	Liquid drop model approach, Semi-empirical mass formula	1	1	1, 2, 4
	Evidence for nuclear shell structure, nuclear magic numbers, Basic assumptions of shell model	1	1,2	1, 2, 4
	Concept of nuclear force, classification of nuclei, stability of nuclei (N vs Z Curve)	1	1,2	1, 2, 4
	Magnetic moments Nuclear magnetic dipole moment	1	1	1, 2, 4
	Tutorial – 2	1	1	1, 2, 4
	Electric Quadropole moment	1	1	1, 2
	Nuclear Energy levels and Excited states	1	1,2	1, 2
	Tutorial – 3	1	1	1, 2
	Unit No. 2	Radioactivity	12	
Radioactivity disintegration, natural and artificial radioactivity, Half-life		1	1, 2	1, 2, 4
Alpha decay, measurement of velocity and energy of alpha particles, Geiger-Nuttall law		1	2	1, 2, 4
Tunnelling of alpha particle, Alpha particle spectra, nuclear energy levels,		1	2	1, 2, 4
Tutorial – 4		1	2	1, 2, 4
Beta decay: velocity and energy of beta particles, beta spectra		1	2	1, 2, 4
Neutrino, positron emission and orbital electron Capture		1	2	1, 2, 4
Gamma rays: Nature of gamma rays, passage through matter, Photo-electric absorption, Compton scattering		1	2	1, 2, 4
Tutorial – 5		1	2	1, 2, 4
Pair production , nuclear energy levels and gamma ray spectra		1	2	1, 2, 4
Determination of gamma ray energies		1	1, 2	1, 2, 4
Application of radioactivity: Agricultural, Medical, Industrial, Archaeological		1	2	1, 2
Tutorial – 6		1	2	1, 2, 4
	Nuclear Reactions	12		
	Neutron: mass, lifetime, energy	1	4	1, 2
	Artificial transmutation, types of Nuclear reactions, conservation laws	1	4	1, 2
	Compound nuclear Q-value equation	1	4	1, 2
	Tutorial – 7	1	4	1, 2

Unit No. 3	Exothermic and Endothermic reaction, Threshold energy	1	4	1, 2
	Nuclear cross-section, reaction yield	1	4	1, 2
	Nuclear fission, chain reaction and critical mass	1	4	1, 2
	Tutorial – 8	1	4	1, 2
	Nuclear reactor and its basic components, Homogeneous and heterogeneous reactors	1	4	1, 2
	Power reactor, fast breeders	1	4	1, 2
	Nuclear fusion, Nucleosynthesis (Qualitative)	1	4	1, 2
	Tutorial – 9	1	4	1, 2
Unit No. 4	Elementary particle physics	12		
	Fundamental forces and their basic features	1	1, 3	1, 2, 3
	Types of particles and its families	1	1, 3	1, 2, 3
	Conservation Laws: energy, linear momentum & angular momentum	1	1, 3	1, 2, 3
	Tutorial – 10	1	1, 3	1, 2, 3
	Parity, baryon number, Lepton number, Isospin	1	1, 3	2, 3, 4
	Concept of quark model, the Gell-Mann/Nishijima formula	1	3	2, 3
	Electromagnetic interaction and Photon	1	3	3
	Strong interaction, Colour quantum number	1	3	3
	Neutrinos, Cosmic Rays	1	3	3
	Electroweak interaction, W/Z bosons	1	3	2, 3, 4
	Tutorial – 11	1	3	3
	Tutorial – 12	1	3	3
Unit No. 5	Particle Detectors and Accelerator	12		
	Gas filled Detectors (G. M. counter)	1	2, 4	1, 2
	Solid-state detectors (scintillation counter)	1	2, 4	1, 2
	Photo-multiplier tube (PMT)	1	2, 4	1, 2
	Tutorial – 13	1	2, 4	1, 2
	Semi-conductor detector	1	2, 4	1, 2
	Cherenkov detector	1	2, 4	1, 2
	Van-de Graaff generator	1	2, 4	2, 3
	Tutorial – 14	1	2, 4	2, 3
	Particle Accelerators: Cyclotrons	1	3, 4	2, 3
	Synchrotrons	1	3, 4	2, 3
	Linear accelerators	1	3, 4	2, 3
	Tutorial – 15	1	3, 4	2, 3
Total Contact Hours		60		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50 %)								End Semester Exam (50 %)	
		CLA-1 (15 %)		CLA-2 (15 %)		CLA-3 (_ %)		Mid Term (20 %)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	60%		40%			40%		30%		
	Understand										
Level 2	Apply	40%		60%			60%		70%		
	Analyse										
Level 3	Evaluate										
	Create										
Total		100%		100%				100%		100%	

Recommended Resources

1. Krane, K. S. (Year). Introductory Nuclear Physics, Student ed. Wiley.
2. Ghosal, S. N. (Year). Nuclear Physics, Revised ed. S Chand Publishing.
3. Griffiths, D. (Year). Introduction to Elementary Particles, 2nd ed. Wiley-VCH.
4. Beiser, A. (Year). Concept of Modern Physics, 6th ed. McGraw-Hill Publishing

Other Resources

Mentored Project

Course Code	PHY 306	Course Category	RDIP				L	T	P	C
							0	0	4	4
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)						
Course Offering Department	Physics	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

1. To widen the understanding of doing research.
2. To facilitate the ideation of a thought.
3. To devise and plan ways to execute an idea.
4. To learn how to avoid plagiarism and publish one's contribution in the research community.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Conceptualized idea.	3	75%	70%
Outcome 2	Implement the mathematical model/experimental plan.	4	75%	70%
Outcome 3	Conduct the simulation/analysis/experiments and extract the results	5	75%	70%
Outcome 4	Validate the results obtained with Literature survey.	5	70%	65%
Outcome 5	Publish and present findings in reputed journals and conferences.	5	75%	70%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	3	3	2				3			2	3	2	3
Outcome 2	3	3	3	3	2				2			3	3	3	3
Outcome 3	3	3	3	3	2				3			3	3	3	3
Outcome 4	3	3	3	3	3				3			3	3	3	3
Outcome 5	3	3	3	3	3				3			3	3	3	3
Average	3	3	3	3	2.4				2.8			2.8	3	2.8	3

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact hours	CLOs Addressed	References Used
Unit No. 1	Refinement of Idea	20	1	1-7
Unit No. 2	Implement the Mathematical model	40		
	Optimize the mathematical model for the considered problem	30	2	
	Creating timeline for execution of various module of the project.	10	2	
Unit No. 3	Conduct the simulation analysis and extract the results	30		
	Perform the experimental simulations.		3	
Unit No. 4	Validate the results obtained with Literature survey	15	3,4	
Unit No. 5	Publish and present results and finding	15	5	
Total		120 hours		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50 %)						End Semester Exam (50%)	
		CLA-1 (15 %)		CLA-2 (15 %)		Mid Term (20%)		Project (50%)	
		Th	Prac	Th	Prac	Th	Prac		Proj
Level 1	Remember								
	Understand								
Level 2	Apply		80%		70%		70%		60%
	Analyse								
Level 3	Evaluate		20%		30%		30%		40%
	Create								
Total			100%		100%		100%	50%	50%

Recommended Resources

1. As recommended by Advisor pertaining to student research interest.
2. Research Methodology
3. Reading assignment related to undergraduate project as guided by faculty
4. <https://ieeexplore.ieee.org/Xplore/home.jsp>
5. <https://www.sciencedirect.com/>
6. www.springer.com
7. <https://onlinelibrary.wiley.com/>

Other Resources

Research Degree Project I

Course Code	PHY 401	Course Category	RDIP				L	T	P	C
							0	0	5	5
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)						
Course Offering Department	Physics	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

1. Students will master advanced research techniques, including experimental design, data analysis, and critical literature review, to investigate specific research topics.
2. Through presentations and reports, students will learn to effectively communicate scientific findings, tailoring their message to diverse audiences.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Sketch the theme of the research project and demonstrate the advanced methods needed for theoretical modeling/experimental design	3	75%	70%
Outcome 2	Proficiently analyze data, create plots, and draw meaningful conclusions.	4	75%	70%
Outcome 3	Prepare a scientific project report and convey the scientific findings through oral presentations.	5	75%	70%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	2	3	2	1	2	3	3	2	2	3	3	2	3
Outcome 2	3	3	3	3	3	1	2	3	3	3	3	3	2	3	3
Outcome 3	3	3	3	3	3	2	2	3	3	3	3	3	2	3	3
Average	3.0	3.0	2.7	3.0	2.7	1.3	2.0	3.0	3.0	2.7	2.7	3.0	2.3	2.7	3.0

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact hours	CLOs Addressed	References Used
Unit No. 1	Refinement of Idea	20	1	1-6
Unit No. 2	Implement the Mathematical model Optimize the mathematical model for the considered problem	30	2	
Unit No. 3	Conduct the simulation/experimental data analysis and extract the results	50	2	
Unit No. 4	Validate the results obtained with Literature survey	30	2,3	
Unit No. 5	Publish and present results and finding	20	3	
Total Contact Hours		150 hours		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50 %)						End Semester Exam (50%)	
		CLA-1 (15 %)		CLA-2 (15 %)		Mid Term (20 %)		Project (50%)	
		Th	Prac	Th	Prac	Th	Prac		Proj
Level 1	Remember								
	Understand								
Level 2	Apply		80%		70%		70%		60%
	Analyse								
Level 3	Evaluate		20%		30%		30%		40%
	Create								
Total			100%		100%		100%		100%

Recommended Resources

1. As recommended by the Advisor pertaining to student's research interest.
2. <https://arxiv.org/>
3. <https://www.sciencedirect.com/>
4. www.springer.com
5. <https://onlinelibrary.wiley.com/>
6. <https://www.overleaf.com/learn/latex/Tutorials> (For Latex)

Other Resources

Research Degree Project II

Course Code	PHY 402	Course Category	RDIP				L	T	P	C
							0	0	12	12
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)						
Course Offering Department	Physics	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

- Students will master advanced research techniques, including experimental design, data analysis, and critical literature review, to investigate specific research topics.
- Through presentations and reports, students will learn to effectively communicate scientific findings, tailoring their message to diverse audiences.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Sketch the theme of the research project and demonstrate the advanced methods needed for theoretical modeling/experimental design	3	75%	70%
Outcome 2	Proficiently analyze data, create plots, and draw meaningful conclusions.	4	75%	70%
Outcome 3	Prepare a scientific project report and convey the scientific findings through oral presentations.	5	75%	70%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	2	3	2	1	2	3	3	2	2	3	3	2	3
Outcome 2	3	3	3	3	3	1	2	3	3	3	3	3	2	3	3
Outcome 3	3	3	3	3	3	2	2	3	3	3	3	3	2	3	3
Average	3	3	2.7	3	2.7	1.3	2	3	3	2.7	2.7	3	2.3	2.7	3

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact hours	CLOs Addressed	References Used
Unit No. 1	Refinement of Idea	20	1	1-6
Unit No. 2	Implement the Mathematical model Optimize the mathematical model for the considered problem	30	2	
Unit No. 3	Conduct the simulation/experimental data analysis and extract the results	50	2	
Unit No. 4	Validate the results obtained with Literature survey	30	2,3	
Unit No. 5	Publish and present results and finding	20	3	
Total Contact Hours		150 hours		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50 %)						End Semester Exam (50%)	
		CLA-1 (15 %)		CLA-2 (15 %)		Mid Term (20%)		Project (50%)	
		Th	Prac	Th	Prac	Th	Prac		Proj
Level 1	Remember								
	Understand								
Level 2	Apply		80%		70%		70%		60%
	Analyse								
Level 3	Evaluate		20%		30%		30%		40%
	Create								
Total			100%		100%		100%		100%

Recommended Resources

1. As recommended by the Advisor pertaining to the student's research interest.
2. <https://arxiv.org/>
3. <https://www.sciencedirect.com/>
4. www.springer.com
5. <https://onlinelibrary.wiley.com/>
6. <https://www.overleaf.com/learn/latex/Tutorials> (For Latex)

Other Resources

Numerical Methods and Simulation Techniques

Course Code	PHY 423	Course Category	CE				L	T	P	C
							2	0	2	4
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)						
Course Offering Department	Physics	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

1. Familiarize error analysis, root finding methods, interpolation and curve fitting of data sets.
2. Introduce linear and polynomial regression methods and numerical differentiation and integration techniques.
3. Solve initial value and boundary value problems and understand Monte Carlo and Molecular dynamics techniques.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Relate error analysis with significant digits, find roots using bisection, Newton-Raphson, and secant methods.	2	70%	65%
Outcome 2	Utilize regression techniques like linear and polynomial regression, curve fitting techniques, and demonstrate proficiency in numerical differentiation and integration methods solving diverse problems	3	70%	65%
Outcome 3	Employ numerical solutions to ordinary differential equations, including Taylor series, Euler method, Heun's method, and Runge-Kutta methods.	3	70%	65%
Outcome 4	Analyze the behavior of numerical solutions and their convergence properties including Monte Carlo simulations	3	70%	65%
Outcome 5	Validate the application of molecular dynamics in practical scenarios.	5	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	3	3	2	2	-	2	1	2	2	2	3	1	2
Outcome 2	3	3	3	2	2	2	-	2	2	2	2	3	3	2	2
Outcome 3	3	3	3	3	2	2	1	2	2	3	2	3	3	2	2
Outcome 4	3	3	3	3	2	2	1	2	3	3	2	3	3	2	2
Outcome 5	3	2	3	3	3	2	1	2	2	3	3	3	2	2	2
Average	3	2.8	3	2.8	2.2	2	1	2	2	2.6	2.2	2.8	2.8	1.8	2

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Roots of non-linear equations, interpolation of data, curve fitting	6		
	Error analysis and estimates	1	1	1,2,3
	Significant digits, convergence	1	1	1,2,3
	Roots of non-linear equations, Bisection method	1	1	1,2,3
	Newton Raphson method, Secant method	1	1	1,2,3
	Interpolation of data, curve fitting	1	2	1,2,3
	Statistical interpolation of data, example solutions	1	2	1,2,3
Unit No. 2	Numerical differentiation	6		
	Regression method	1	2	1,2,3
	Linear regression and polynomial regression	1	2	1,2,3
	Introduction to Numerical differentiation	1	2	1,2,3
	Newton's Forward difference method	1	2	1,2,3
	Newton's Backward difference method	1	2	1,2,3
	Solving Examples and error analysis	1	1,2	1,2,3
Unit No. 3	Numerical Integration	6		
	Introduction to Numerical Integration method	1	3	1,2,3
	Integration based on uniform mesh spacing	1	3	1,2,3
	Trapezoidal rule	1	3	1,2,3
	Simpson's 1/3 rule	1	3	1,2,3
	Solving Examples using different approaches	1	3	1,2,3
	Calculating errors and convergence	1	3,4	1,2,3
Unit No. 4	Solutions of differential equations, Monte Carlo techniques	6		
	Ordinary differential equations and numerical solutions	1	3	1,2,3
	Taylor series, Euler method	1	3	1,2,3
	Heun's method, Runge – Kutta method	1	3	1,2,3
	Introduction to Monte Carlo method	1	3,4	1,2,3
	Importance samplings, Metropolis Algorithm	1	3,4	
	Solving examples using Monte Carlo method	1	3,4	1,2,3
Unit No. 5	Molecular dynamics technique	6		
	Introduction to molecular dynamics	1	5	1,2,3
	Various interaction terms in Force Field	1	5	1,2,3
	Non – bonded and Bonded Interactions	1	5	1,2,3
	Integration scheme	1	5	1,2,3
	Thermostat and Barostat	1	5	1,2,3
	Applications of Molecular dynamics	1	5	1,2,3
Total Contact Hours			30	

Course Unitization Plan - Project

S. No.	Project Name	Required Contact Hours	CLOs Addressed	References Used
1	Root finding, interpolation and curve fitting	12	1	1,2,3
2	Differentiation techniques	12	2	1,2,3
3	Integration techniques	12	3	1,2,3
4	Monte Carlo method	12	4	1,2,3
5	Molecular Dynamics method	12	5	1,2,3
Total Contact Hours		60		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50 %)								End Semester Exam (50 %)	
		CLA-1 (15 %)		CLA-2 (15 %)		CLA-3 (_ %)		Mid Term (20 %)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Project
Level 1	Remember	60%		40%			40%		20%		
	Understand										
Level 2	Apply	40%		40%			60%		30%	30%	
	Analyse										
Level 3	Evaluate			20%						20%	
	Create										
Total		100%		100%				100%		50%	50%

Recommended Resources

1. Epperson, J. F. (2013). An Introduction to Numerical Methods and Analysis, 2nd ed. Hoboken, NJ: Wiley.
2. Baskar, S. (Year). Introduction to Numerical Analysis. Place of publication: Publisher.
3. Iyengar, S. R. K., & Jain, R. K. (Year). Numerical Methods. Place of publication: New Age International Publishers.

Other Resources

1. National Programme on Technology Enhanced Learning (NPTEL). (2019). Introduction to Electromagnetic Theory. Retrieved from https://onlinecourses.nptel.ac.in/noc19_ph11/preview
2. National Programme on Technology Enhanced Learning (NPTEL). (2022). Applied Linear Algebra. Retrieved from https://onlinecourses.nptel.ac.in/noc22_ma39/preview

Introduction to LabVIEW and ZView

Course Code	PHY 427	Course Category	CE				L	T	P	C
							0	0	4	4
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)						
Course Offering Department	Physics	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

1. To learn use of LabVIEW graphical interface
2. To learn LabVIEW for mathematical operations, and interfacing of research equipment
3. To learn impedance spectroscopy tool using ZVIEW graphical interface
4. To analyze impedance data using equivalent circuits
5. To gain insight of electrical properties of ceramics

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Understand operation of LabVIEW and ZVIEW software	2	70%	65%
Outcome 2	Apply mathematical functions, Boolean logic, and analysis in LabVIEW VIs.	3	70%	65%
Outcome 3	Develop skills in communicating with hardware equipment using LabVIEW and creating instrument drivers.	4	70%	65%
Outcome 4	Perform I-V, Cp-D, and impedance measurements using specific equipment	5	65%	60%
Outcome 5	Analyze the impedance spectroscopy data to derive dielectric properties and electroactive regions of materials.	5	60%	55%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	1			1	1	3						2		1	2
Outcome 2	2	3	1	3	1	3						2		2	2
Outcome 3	2	3	2	3	3	3						3		3	3
Outcome 4	2	3	2	3	3	3		2	2	2		2	2	3	3
Outcome 5	2	3	3	3	3	3		2	2	2		2	3	3	2
Average	1.8	3	2	2.6	2.2	3		2	2	2		2.2	2.5	2.4	2.4

Course Unitization Plan

S. No.	Description of experiments	Required Contact Hours	CLOs Addressed	Reference
1.	Creating a Labview VIs (Virtual Instrument): Project, block diagram and tablets in front panel, using various pallets	4	1	1,2
2.	Creating VIs with various math functions, Boolean logics and perform analysis	4	2	1,2
3.	Creating VIs using loops, time functions, building waveforms	4	1, 2	1,2
4.	Communication with an equipment: Hardware/software, using instrument drivers, making your own driver	4	3	1,2
5.	I-V measurements with Tektronics source meter, data collection, data saving, and live plot	8	4	1,2
6.	C _p -D measurements with Keysight LCR meter, data collection, data saving, and live plot	8	4	1,2
7.	Introduction to impedance. Functionalities of ZView.	4	4, 5	3,4
8.	Impedance measurements using LCR meter and data collection using LabVIEW program	4	4	3,4
9.	Simulating impedance data for various equivalent circuits	4	5	3,4
10.	Making parallel, series circuits using capacitance, resistance, inductance and verify the equivalent circuits using impedance measurements	4	4, 5	3,4
11.	Impedance spectroscopy of oxide materials and analysis using ZVIEW. Materials insight: grain, grain-boundary and electrode response	8	5	3,4,5
12.	Deriving dielectric properties of BaTiO ₃ /SnF ₂ from impedance data.	4	5	3,4,5
Total contact hours (Experiments)		60		

Course Unitization Plan – Project

Exp No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
1	Interface Keysight E4980A LCR meter for Capacitance – Voltage measurements and measure	30	2, 3, 4, 5	1,2
	Interface Keithley 6430 for Current – Voltage measurements and characterize a given semiconductor		2, 3, 4, 5	1,2
2	Characterize a given ceramic and identify various electroactive regions using impedance spectroscopy and ZView	30	2, 3, 4, 5	3,4,5
	Identify the ionic behavior of a given material using impedance spectroscopy and ZView		2, 3, 4, 5	3,4,5
Total Contact Hours		60		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50 %)								End Semester Exam (50 %)	
		CLA-1 (15 %)		CLA-2 (15 %)		CLA-3 (___%)		Mid Term Model Exam(20%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Prac	Proj
Level 1	Remember		20%		20%				30%	10%	5%
	Understand										
Level 2	Apply		60%		60%				50%	30%	25%
	Analyse										
Level 3	Evaluate		20%		20%				20%	10%	20%
	Create										
Total			100%		100%				100%	50%	50%

Recommended Resources

1. Travis, J., & Kring, J. (2007). LabVIEW for Everyone: Graphical Programming Made Easy and Fun. 3rd edition. Upper Saddle River, NJ: Prentice Hall.
2. Johnson, G. W. (2006). LabVIEW Graphical Programming: Practical Applications in Instrumentation and Control. 4th edition. New York, NY: McGraw-Hill Education.
3. MacDonald, J. R., & Barsukov, Y. (2005). Impedance Spectroscopy: Theory, Experiment, and Applications. 2nd edition. Hoboken, NJ: Wiley-Interscience.
4. Scribner Associates, Inc. (2024). ZView® for Windows. User Manual.
5. Irvine, J. T. S., Sinclair, D. C., & West, A. R. (1990). Electroceramics: Characterization by Impedance Spectroscopy. *Advanced Materials*, 2(3), 132–138. <https://doi.org/10.1002/adma.19900020304>

Introduction to Soft matter Physics

Course Code	PHY 422	Course Category	CE				L	T	P	C
							3	1	0	4
Pre-Requisite Course(s)	Statistical Physics	Co-Requisite Course(s)		Progressive Course(s)						
Course Offering Department	Physics	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

1. Introduction to soft matter systems.
2. Soft matter in solutions and its understanding.
3. To study various soft matter systems: colloids, liquid crystals, surfactants.
4. To learn the effect of flow, deformation, and material responses.
5. To develop understanding about various experimental and computational tools and analyse soft matter systems.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Summarize preliminary details about various soft matter systems and its properties	2	70%	65%
Outcome 2	Classify different properties of soft matter systems in presence of solutions	2	70%	65%
Outcome 3	Investigate colloids, liquid crystals, surfactant molecules and its properties, applications	3	70%	65%
Outcome 4	Inspect the effect of flow in a soft matter system, its structural changes, response of external flow	4	70%	65%
Outcome 5	Examine various experimental and computational approaches in studying soft matter systems	4	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	1			1		1	1			-	2	3	1	1
Outcome 2	3	1		1	1		1	-			-	3	3	2	1
Outcome 3	3	2	2	2	2		-	-			-	2	3	2	2
Outcome 4	3	3	2	3	3	2	-	-	1	1	-	2	3	2	2
Outcome 5	3	3	2	3	3	2	-	-	1	2	1	3	2	3	3
Average	3	2	2	2.25	2	2	1	1	1	1.5	1	2.4	2.8	2	1.8

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact hours	CLOs Addressed	Reference Used
Unit No. 1	Introduction to Soft Matter	12		
	What is soft matter and why soft matter?	1	1,2	1,2
	Various examples: Polymers, surfactants, colloids, liquid crystals	1	1,2	1,2
	Characteristic properties of soft matter systems	1	1,2	1,2
	What is common in soft matter?	1	1,2	1,2
	Different Interactions: Bonded interaction and non-bonded	1	1,2	1,2
	Fluctuations in the systems, Brownian motion	1	1,2	1,2
	Random Walk problem	1	1,2	1,2
	Langevin dynamics	1	1,2	1,2
	Fluctuation dissipation theorem	1	1,2	1,2
	Tutorial – I	1	1,2	1,2
	Tutorial – II	1	1,2	1,2
Tutorial – III	1	1,2	1,2	
Unit No. 2	Soft matter solutions	12		
	Basic concepts and thermodynamics of solutions	1	1,2	1,2
	Mixing free energy, Osmotic pressure, Chemical Potentials	1	1,2	1,2
	Relations with miscibility of solute and solvents	1	1,2	1,2
	Soft matter solutions and its essential characteristics	1	1,2	1,2
	Phase separation and coexistence of two phases	1	1,2	1,2
	Lattice model description and effective interaction	1	1,2	1,2
	Lattice model of polymer solutions	1	1,2	1,2
	Structure factor, form factor, effect of correlation	1	1,2	1,2
	Multi-component solutions	1	1,2	1,2
	Tutorial – IV	1	1,2	1,2
	Tutorial – V	1	1,2	1,2
Tutorial – VI	1	1,2	1,2	
Unit No. 3	Colloids, Liquid crystals, and surfactants	12		
	Classification, basic concepts of elasticity of polymer	1	2,3	1,2
	Continuum mechanics for elastic materials	1	2,3	1,2
	Freely jointed chain model, end – to end length	1	2,3	1,2
	Kuhn’s theory for rubber elasticity	1	2,3	1,2
	Surface and surface tensions, examples	1	2,3	1,2
	Wetting phenomenon, Liquid droplet on surface	1	2,3	1,2
	Colloids	1	2,3	1,2
	Liquid crystals	1	2,3	1,2
	Surfactants	1	2,3	1,2
	Tutorial – VII	1	2,3	1,2
	Tutorial – VIII	1	2,3	1,2
Tutorial – IX	1	2,3	1,2	
Unit No. 4	Flow and Deformation	12		
	Mechanical properties of soft matter	1	2,3,4	1,2,3,4,5
	Concepts of viscosity, elasticity, and viscoelasticity	1	2,3,4	1,2,3,4,5
	Viscoelasticity of entangled polymers	1	2,3,4	1,2,3,4,5
	Viscoelasticity of non-entangled polymers	1	2,3,4	1,2,3,4,5
	Examples studies: Rod-like polymers	1	2,3,4	1,2,3,4,5
	Statistical concepts of material response and fluctuations	1	2,3,4	1,2,3,4,5
	Liouville equation, time correlation functions	1	2,3,4	1,2,3,4,5
	Equilibrium and non-equilibrium responses	1	2,3,4	1,2,3,4,5
	Derivation of Smoluchowskii equation from Langevin equation	1	2,3,4	1,2,3,4,5
	Tutorial – X	1	2,3,4	1,2,3,4
	Tutorial – XI	1	2,3,4	1,2,3,4
Tutorial - XII	1	2,3,4	1,2	
Unit No. 5	Experimental and Computational approach to study soft matter systems	12		
	Various experimental techniques: x-ray, neutron scattering, light scattering to study soft matter	1	3,4,5	1,2
	Basic insights gained from experimental approaches	1	3,4,5	1,2
	Computational tools: Monte Carlo, Molecular dynamics	1	3,4,5	1,2
	Introduction to Monte Carlo techniques	1	3,4,5	1,2,3
	Importance sampling, Metropolis Algorithm	1	3,4,5	1,2,3
	Kinetic Monte Carlo approach	1	3,4,5	1,2,3
	Introduction to molecular dynamics	1	3,4,5	1,2,3
	Solving problems applying Monte Carlo	1	3,4,5	1,2,3
	Solving problems applying molecular dynamics	1	3,4,5	1,2,3
	Tutorial – XIII	1	3,4,5	1,2,3
	Tutorial – XIV	1	3,4,5	1,2,3
Tutorial – XV	1	3,4,5	1,2,3	
Total Contact Hours			60	

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50 %)								End Semester Exam (50 %)	
		CLA-1 (15 %)		CLA-2 (15 %)		CLA-3(_%)		Mid Term (20 %)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	60%		40%				40%		30%	
	Understand										
Level 2	Apply	40%		60%				60%		70%	
	Analyse										
Level 3	Evaluate										
	Create										
Total		100%		100%				100%		100%	

Recommended Resources

1. Doi, M. (2013). Soft Matter Physics. Oxford University Press.
2. Brochard-Wyart, F., Nassy, P., & Puech, P-H. (2019). Essentials of Soft Matter Science. CRC Press.
3. Witten, T. A., & Pincus, P. A. (2004). Structured Fluids – Polymers, Colloids, Surfactants. Oxford University Press.
4. Chaikin, P. M., & Lubensky, T. C. (1995). Principles of Condensed Matter Physics. Cambridge University Press, Cambridge, England.
5. National Programme on Technology Enhanced Learning (NPTEL). (2020). Introduction to Soft Matter. Available at: https://onlinecourses.nptel.ac.in/noc20_me05/preview.

Introduction to Astrophysics

Course Code	PHY 421	Course Category	CE				L	T	P	C
							3	1	0	4
Pre-Requisite Course(s)	PHY203, PHY212, PHY302	Co-Requisite Course(s)		Progressive Course(s)						
Course Offering Department	Physics	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

- To introduce the basics of Astrophysics such as Astronomical coordinate system, distance and mass measurement techniques, stellar radiation
- To discuss the stellar structure, stellar spectra, and stellar evolution
- To familiarize the Astronomical instruments and discuss the recent discoveries in Astronomy

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Understand astronomical scales, coordinate systems, stellar mass measurements, different types of binaries, apparent and absolute magnitude of stellar objects, while simultaneously relating to the concepts of blackbody radiation, emission and absorption spectra in Astrophysics	2	70%	65%
Outcome 2	Analyze the stellar structure and star formation processes, evaluate gravitational and thermal energy within stars using the virial theorem, apply the concept of binding energy and tunnelling effect to calculate the nuclear energy production within a star	3	70%	65%
Outcome 3	Classify the Sun as a typical star, identify different regions of the Sun, Use HR diagrams to classify main sequence stars, white dwarfs, red dwarfs, type Ia and type II supernovae and relate to the structures of galaxies and galaxy rotation curves	3	70%	65%
Outcome 4	Illustrate an understanding of stellar evolution and formation and connect to the concepts of black holes, neutron stars, Chandrasekhar limit, accretion, and accretion disk.	4	70%	65%
Outcome 5	Analyze recent astronomical observations using advanced instruments, illustrate groundbreaking discoveries like gravitational waves detected by LIGO, and critically assess unresolved questions in astrophysics.	2	65%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Life-Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	3	3	2	1	-	2	2	2	1	2	2	2	2
Outcome 2	3	3	3	3	2	1	-	2	2	2	1	3	2	2	2
Outcome 3	3	2	2	2	2	1	-	2	2	2	1	2	3	2	3
Outcome 4	3	3	3	3	3	1	-	3	2	2	1	3	3	2	3
Outcome 5	3	2	2	2	3	1	1	2	3	2	2	3	3	2	3
Average	3	2.4	2.4	2.4	2.4	1	1	2.2	2.2	2	1.2	2.4	2.4	2	2.4

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Introduction to Astronomy and Astronomical Scales	12		
	Motivation & brief history of Astronomy, scales related to Astronomy	1	1	1, 4, 6
	How do we collect the information about the Universe	1	1	1, 4, 6
	The sky and the celestial sphere	1	1	1, 4, 6
	Application of Physics to Astrophysics	1	1	1, 4, 6
	Tutorial: Kepler law and Kepler orbit	1	1	1, 4, 6
	Doppler effect	1	1	1, 4, 6
	Determination of distance by using parallax technique	1	1	1, 4, 6
	Tutorial: Aberration	1	1	1, 4, 6
	Stellar mass measurement: Visual, eclipsing binaries	1	1	2, 4, 5, 6
	Stellar mass measurement: Spectroscopic binaries	1	1	2, 4, 5, 6
	Tutorial: <ul style="list-style-type: none"> • Radiation Luminosity, Flux 	1	1	2, 4, 5, 6
	Radius and temperature of stars	1	1	2, 4, 5, 6
	Unit No. 2	Stellar Structure	12	
Tutorial: Blackbody radiation		1	1	2, 4, 5, 6
Tutorial: Emission and absorption spectra		1	1	2, 4, 5, 6
Basic equations for stellar structure, Hydrostatic equilibrium in stars		1	2	2, 4, 5, 6
Virial theorem		1	2	2, 4, 5, 6
Energy transport in stars		1	2	2, 4, 5, 6
Construction of stellar models, Relation among stellar quantities		1	2	2, 4, 5, 6
Nuclear energy production: Binding energy per nucleon, Efficiency of fusion		1	2	2, 4, 5, 6
Tunnelling in the Coulomb barrier, Gamow peak		1	2	2, 4, 5, 6
Important nuclear reactions in stars: pp chain, Neutrino production		1	2	2, 4, 5, 6
Observed stellar spectra: Main sequence		1	3	2, 4, 5, 6
Luminosity dependence on mass, Stellar classification based on spectra		1	3	2, 4, 5, 6
Tutorial: Luminosity Stellar classification		1	3	2, 4, 5, 6
Unit No. 3	Stellar Structure & Sun as a star	12		
	Saha ionization, HR diagram	1	2,3	2, 4, 5, 6
	Tutorial: Saha ionization, HR diagram	1	2,3	2, 4, 5, 6
	Solar atmosphere	1	3	5, 6
	Photosphere, Chromosphere	1	3	2, 5, 6
	Transition Region, Corona	1	3	2, 5, 6
	Solar Luminosity, Solar temperature, density profiles	1	3	5,6
	Photospheric absorption lines, Limb Darkening	1	3	5, 6
	Tutorial: Solar Wind	1	3	5, 6
	Thomson Scattering, Mean free Path	1	3	5,6
	Photon diffusion inside the Sun (qualitative description)	1	3	2, 5, 6
	X – Ray Emission, Magnetic Fields			
	Tutorial: Sunspot	1	3	2, 5, 6
	Stellar evolution, Galaxy	12		
	Stellar evolution: Mass loss from stars, Stellar winds	1	2,4	5, 6

Unit No. 4	Supernovae	1	3	2, 5, 6
	Tutorial: White Dwarf	1	3	5, 6
	Neutron star	1	4	2, 5, 6
	Black hole and Chandrasekhar limit	1	4	2, 5, 6
	Tutorial: Extra solar planet	1	4	5, 6
	Binary Systems: Classification of Binary Stars	1	1,4	3, 5, 6
	Basic Structure & properties of different types of Galaxies	1	4	3, 5, 6
	Tutorial: Milky Way	1	4	3, 5
	Nature of rotation of Milky Way	1	4	3, 5
	Nature of rotation continues (Differential rotation of the Galaxy)	1	4	3, 5
	Brief idea of Dark Matter	1	4	3, 5
Unit No. 5	Recent Observations in Astronomy	12		
	Accretion (gas accretion onto black holes or neutron stars.)	1	4,5	2, 5
	Accretion cont. (Origin of accreted gas, geometry (Bondi/disk))	1	4,5	2, 5
	Tutorial: Astronomical Instruments: Basic Optical Definitions for Magnification, Light Gathering Power	1	5	4, 5
	Tutorial: Astronomical Instruments cont.: Limiting magnitude, Resolving Power, Diffraction Limit	1	5	4, 5
	Astronomical Instruments cont.: Optical telescopes	1		4, 5
	Hubble space telescope	1	5	4, 5
	A brief introduction to the theory of Gravitational waves: An introduction to how LIGO works?	1	5	7
	Tutorial: Discoveries of 2015 and 2017 GWs signal from the published manuscript	1	5	7
	Open questions in Astrophysics	1	5	2, 5, 7
	Why to look beyond the Astrophysical scale - Gateway to Cosmology	1	5	2, 3, 5
	What Cosmology deals with	1	5	2, 3, 5
	Recap of essential aspects of the course	1	5	2, 3, 5, 7
Total Contact Hours				60

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50 %)								End Semester Exam (50 %)	
		CLA-1 (15 %)		CLA-2 (15 %)		CLA-3 (_ %)		Mid Term (20 %)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	60%		40%			40%		30%		
	Understand										
Level 2	Apply	40%		60%			60%		70%		
	Analyse										
Level 3	Evaluate										
	Create										
Total		100%		100%			100%		100%		

Recommended Resources

1. Padmanabhan, T. (2000). Theoretical Astrophysics, Vol-1: Astrophysical Processes. 1st ed, Cambridge: Cambridge University Press.
2. Padmanabhan, T. (2001). Theoretical Astrophysics, Vol-II: Stars and Stellar Systems. 1st ed, Cambridge: Cambridge University Press.
3. Padmanabhan, T. (2002). Theoretical Astrophysics, Vol-III: Galaxies and Cosmology. 1st ed, Cambridge: Cambridge University Press.
4. Jain, P. (2016). An Introduction to Astronomy and Astrophysics. 1st ed, Cambridge: Cambridge University Press
5. Carroll, B. W., & Ostlie, D. A. (2006). An Introduction to Modern Astrophysics. 2nd ed, San Francisco, CA: Pearson Addison Wesley.
6. Choudhuri, A. R. (2010). Astrophysics for Physicists. Cambridge: Cambridge University Press.
7. https://labcit.ligo.caltech.edu/~rana/docs/LIGO_Science.pdf

Other Resources

1. https://labcit.ligo.caltech.edu/~ajw/gwaves_review.pdf
2. https://indico.cern.ch/event/806259/attachments/1922819/3186014/CERN_Academic_Lecture_1_Jo_van_den_Brand.pdf
3. https://indico.cern.ch/event/806260/attachments/1923785/3186015/CERN_Academic_Lecture_2_Jo_van_den_Brand.pdf
4. <https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.116.061102>
5. <https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.119.161101>
6. <https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.125.101102>

Electronic Materials & Device Physics

Course Code	PHY 424	Course Category	CE				L	T	P	C
							2	0	2	4
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)						
Course Offering Department	Physics	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

1. To provide a thorough understanding of the behavior of semiconductors and how crystal structures, energy bands, and electron configurations influence material behavior.
2. To involve students in understanding device characteristics, modes of operation, and their applications in electronic circuits.
3. To Investigate electronic properties of semiconductors and related device performance.
4. To understand the fundamental working mechanisms of PN Junctions, heterojunctions (HBTs) and field effect transistors (FETs).
5. To keep students informed about recent advancements and trends in electronic materials and device technologies, enabling them to adapt to changing industry landscapes

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Summarize different types of electronic materials, their crystal structures, and the band theory of solids.	2	70%	65%
Outcome 2	Explain the fundamental processes of semiconductor physics, i.e., generation, recombination, and transport of electron-hole pairs.	2	70%	65%
Outcome 3	Investigate electronic properties of semiconductors and related device performance.	3	70%	65%
Outcome 4	Illustrate fundamental working mechanisms of PN Junctions, heterojunctions (HBTs), and field effect transistors (FETs).	3	70%	65%
Outcome 5	Apply measurement techniques to evaluate semiconductor devices	4	65%	60%
Outcome 6	Design fabrication semiconductor device and evaluate relevant parameters	5	65%	60%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	1	1	2	2							1	3	1	1
Outcome 2	2	2	1	3	3							2	2	2	1
Outcome 3	2	3	2	3	3	2			2			2	2	3	2
Outcome 4	2	3	2	3	3	3	2	3	2			2	2	3	3
Outcome 5	2	3	2	3	3	3	2	3	2			2	2	3	3
Outcome 6	2	3	2	3	3	3	2	3	2			2	2	3	3
Average	2.0	2.5	1.7	2.8	2.8	2.8		3.0	2.0			1.8	2.2	2.5	2.2

Course Unitization Plan

Unit No.	Syllabus Topics	Req. Contact hours	CLOs Addressed	Ref. Used
Unit No. 1	Introduction to Electronic Materials	6		
	Electronic materials and their importance in modern technology	1	1	1,2
	Crystal structure and bonding: review	1	1	1,2
	Review - band theory and classification of solids;	1	1	1,2
	Conductors, semiconductors, insulators, and dielectrics	1	1	1,2
	Defects in solids: Point defects	1	1, 2, 3	1,2
	Line defects and dislocations	1	1, 2, 3	1,2
Unit No. 2	Semiconductor Physics	6		
	Charge carriers: electrons and holes.	1	1, 2, 3	1,2,3
	Carrier concentration and Fermi level in equilibrium.	1	1, 2, 3	1,2,3
	Intrinsic and extrinsic semiconductors.	1	1, 2, 3	1,2,3
	Carrier transport: drift and diffusion. Diffusion length and lifetime.	1	1, 2, 3	1,2,3
	Generation and recombination processes.	1	2, 3	1,2,3
	Continuity equation and minority carrier distribution.	1	2, 3	1,2,3
Unit No. 3	PN Junction and Heterojunctions	6		
	Formation and properties of PN junctions.	1	2, 3, 4	1,2,3,4
	Depletion region and built-in potential.	1	2, 3, 4	1,2,3,4
	I-V characteristics of PN junction diodes.	1	2, 3, 4	1,2,3,4
	The capacitance of PN junctions: junction and diffusion capacitance.	1	2, 3, 4	1,2,3,4
	Breakdown mechanisms: Zener and avalanche breakdown.	1	2, 3, 4	1,2,3,4
	Heterojunctions: band alignment and applications.	1	2, 3, 4	1,2,3,4
Unit No. 4	Field-Effect Transistors (FETs)	6		
	Metal-Oxide-Semiconductor Field-Effect Transistors (MOSFETs): structure and operation.	1	2, 3, 4	1,2,3,4
	I-V characteristics of MOSFETs: linear and saturation regions.	1	2, 3, 4	1,2,3,4
	Short-channel effects and scaling issues, Threshold voltage and body effect.	1	2, 3, 4	1,2,3,4
	High-k dielectrics and metal gate technology.	1	2, 3, 4	1,2,3,4
	Junction Field-Effect Transistors (JFETs), High electron mobility transistors (HEMTs), FinFETs and multi-gate transistors	1	4	1,2,3,4
	Emerging FET technologies: organic FETs and 2D material FETs.	1	4	1,2,3,4
Unit No. 5	Electrical Characterization of semiconductors	6		
	Resistivity measurement techniques	1	4,5	3,4,5
	Four-probe, two-probe, van der Paw method	1	4,5	3,4,5
	Solved examples: resistivity	1	4,5	3,4,5
	Lorentz force and Hall effect	1	4,5	3,4,5
	Measurement set-up hand on practice	1	4,5	3,4,5
	Semiconductor analysis using I-V and Hall effect	1	4,5	3,4,5
Total Contact Hours		30		

Course Unitization Plan: Project

S. No.	Description of Experiments	Required Contact Hours	CLOs Addressed	References Used
1	Project topics: Fabrication of inorganic/organic p-n junction/FET	12	5,6	4,5
2	Literature review and experimental plan	12	5,6	4,5
3	Fabrication of device	12	5,6	4,5
4	Characterization of p-n junction or FET transistor	12	5,6	4,5
5	Analyze I-V using drift-diffusion equation in semiconducting materials employing MATLAB	12	5,6	4,5
Total Contact Hours		60		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50 %)								End Semester Exam (50 %)	
		CLA-1 (15 %)		CLA-2 (15 %)		CLA-3 (___%)		Mid Term (20 %)			
		Th	Proj	Th	Proj	Th	Prac	Th	Proj	Th	Proj
Level 1	Remember	20%		20%				10%		20%	
	Understand										
Level 2	Apply	30%	30%	30%	30%			30%	30%	30%	30%
	Analyse										
Level 3	Evaluate		20%		20%			10%	20%		20%
	Create										
Total		50%	50%	50%	50%			50%	50%	50%	50 %

Recommended Resources

1. Streetman, B., & Banerjee, S. (2015). Solid State Electronic Devices (7th ed.). New York, NY: Pearson.
2. Anderson, B. L., & Anderson, R. L. (2017). Fundamentals of Semiconductor Devices (2nd ed.). New York, NY: McGraw-Hill Education.
3. Neamen, D. A. (2012). Semiconductor Physics and Devices: Basic Principles (4th ed.). New York, NY: McGraw-Hill.
4. Boylestad, R. L., & Nashelsky, L. (1995). Electronic Devices and Circuit Theory (4th ed.). New York, NY: Longman Higher Education.
5. Kasap, S. O. (2020). Principles of Electronic Materials and Devices (4th ed.). New York, NY: McGraw-Hill.

Other Resources

1. Tanner, B. K. (1996). Introduction to the Physics of Electrons in Solids (1st ed.). Boston, MA: Addison-Wesley.
2. Pierret, R. F. (1996). Semiconductor Device Fundamentals (4th ed.). Boston, MA: Addison-Wesley.
3. IIT Madras. (2021). Characterization of Materials. N/A, Online: NPTEL. Source Link: <https://nptel.ac.in/courses/113/106/113106062/>
4. MIT. (2008). Fundamentals of Semiconductor Devices. N/A, Online: MIT OpenCourseWare. Source Link: <https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-720-fundamentals-of-semiconductor-devices-spring-2008/>

Device Characterization and Instrumentation

Course Code	PHY 425	Course Category	CE				L	T	P	C
							2	0	2	4
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)						
Course Offering Department	Physics	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

1. Equip students with advanced knowledge of semiconductor characterization techniques.
2. Develop practical skills for performing and interpreting characterization and test results.
3. Understand and apply industry standards and protocols for semiconductor testing.
4. Prepare students for careers in semiconductor research, development, and manufacturing.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Explain concepts of semiconductor characterization techniques, such as IV characterization, CV profiling, and thermal analysis etc	2	70%	65%
Outcome 2	Understand industry standards and protocols for semiconductor testing and reliability assessment.	2	70%	65%
Outcome 3	Assess industry level measurements and characterization techniques for semiconductor industry	3	70%	65%
Outcome 4	Perform semiconductor characterization using advanced research equipment and interpret the results.	4	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	1	1	2	2							1	3	1	1
Outcome 2	2	2	1	3	3							2	2	2	1
Outcome 3	2	3	2	3	3	2			2			2	2	3	2
Outcome 4	2	3	2	3	3	3		2	3	2		2	2	3	3
Average	2.0	2.3	1.5	2.8	2.8	2.5		2.0	3.0	2.0		1.8	2.3	2.3	1.8

Course Unitization Plan

Unit No.	Syllabus Topics	Req. Contact hours	CLOs Addressed	Ref. Used
Unit No. 1	Electrical Characterization Techniques	6		
	Displacement current – review	1	1, 2	1, 4
	IV (Current-Voltage) Measurements and Analysis	1	1, 4	1, 4, 2
	Capacitance-Voltage (C-V) profiling techniques	1	1, 4	1, 4, 2
	Carrier Lifetime and Mobility Measurements	1	1, 4	1, 4, 2
	Deep Level Transient Spectroscopy (DLTS) for trap analysis.	1	1, 3	1, 4, 2
	Solved Examples – I-V, DLTS and CV characteristics	1	1, 4	1, 4, 2
Unit No. 2	Thermal and mechanical characterization	6		
	Thermal conductivity and diffusivity measurements	1	1, 3	1, 5
	Thermo-reflectance imaging for thermal mapping; hotspots in semiconductor devices during operation	1	1, 4	1, 5
	Transmission Line Pulse (TLP) Testing	1	1, 3	1, 5
	Stress-strain analysis in thin films and devices.	1	2, 3	1, 5, 3
	Nano-indentation for hardness and modulus.	1	2, 4	1, 5, 3
	A test example for thermal/mechanical characterization	1	3, 4	1, 5
Unit No. 3	Optical and Structural characterization	6		
	Optical Characterization Methods in semiconductor	1	1, 3	1, 4
	Photoluminescence and Electroluminescence	1	1, 4	1, 4
	Raman Spectroscopy and FTIR (Fourier-transform Infrared) Spectroscopy	1	1, 3	1, 4
	X-ray Diffraction (XRD) Techniques	1	1, 4	1, 4
	Overview of X-ray Photoelectron Spectroscopy (XPS), Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM)	1	1, 3	1, 4
	Test case example of characterizations in a semiconductor	1	3, 4	1, 4
Unit No. 4	Reliability and Failure Analysis	6		
	Reliability Testing Methods	1	2, 3	1, 4, 3
	Stress Testing: HTOL, HAST, and HBM	1	2, 3	1, 4, 3
	Electrostatic Discharge (ESD) and Latch-up Testing	1	2, 4	1, 4, 3
	Failure Analysis Techniques: Physical and Electrical	1	3, 4	1, 3
	Industry Standards and Protocols (JEDEC, MIL-STD)	1	2, 3	1, 4
	Discussion on a test case example	1	3, 4	1, 4
Unit No. 5	Instrumentation & Automation	6		
	Test equipment, semiconductor parameter analyzers	1	2, 4	1, 5
	Automated Test Equipment (ATE) for high-throughput testing	1	2, 4	1, 5
	Integration of robotic systems in characterization labs	1	2, 4	1, 5
	Data acquisition systems and digital interfaces.	1	2, 4	1, 5
	Calibration standards and procedures	1	2, 4	1, 5
	Software tools for automation and data analysis	1	2, 4	1, 5
Total Contact Hours			30	

Course Unitization Plan: Project

S. No.	Description of Experiments	Required Contact Hours	CLOs Addressed	References Used
1	Automation using LabVIEW	12	4	--
2	Project topics on testing of power FET, frequency response and switching of standard semiconductor device	12	4	1,4,5
3	Literature review and experimental plan	12	4	1,4,5
4	Characterization using research lab equipments	12	4	1,4,5
5	Interpret data and compare with the datasheet	12	4	1,4,5
Total Contact Hours		60		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50 %)								End Semester Exam (50 %)	
		CLA-1 (15 %)		CLA-2 (15 %)		CLA-3 (_ %)		Mid Term (20 %)			
		Th	Proj	Th	Proj	Th	Prac	Th	Proj	Th	Proj
Level 1	Remember	20%		20%				20%		20%	
	Understand										
Level 2	Apply	30%	50%	30%	50%			30%	50%	30%	50%
	Analyse										
Level 3	Evaluate										
	Create										
Total		50%	50%	50%	50%			50%	50%	50%	50%

Recommended Resources

- Schroder, D. K. (2015). Semiconductor Material and Device Characterization, 3rd ed., Hoboken, NJ: Wiley-Interscience.
- Rudolph, M. (2011). Microelectronic Test Structures for CMOS Technology, Latest Edition, Berlin: Springer.
- Amerasekera, E. A., & Najm, F. N. (1997). Failure Mechanisms in Semiconductor Devices, 2nd ed., Piscataway, NJ: Wiley-IEEE Press.
- IIT Madras. (2021). Characterization of Materials. N/A, Online: NPTEL. <https://nptel.ac.in/courses/113/106/113106062/>
- MIT. (2008). Fundamentals of Semiconductor Devices. N/A, Online: MIT OpenCourseWare. <https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-720-fundamentals-of-semiconductor-devices-spring-2008/>

Optical Information Processing

Course Code	PHY 426	Course Category	CE				L	T	P	C
			3	0	1	4				
Pre-Requisite Course(s)	PHY 304	Co-Requisite Course(s)		Progressive Course(s)						
Course Offering Department	Physics	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

1. To understand the basic concepts of imaging and imaging systems.
2. To understand propagation characteristics of light using diffraction theory.
3. To learn how to control the light for various practical applications.
4. To gain insights of various light modulation techniques.
5. To learn various optical correlators and how to extract information using them.
6. To understand the holography and various holographic systems.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Understand the concepts of geometrical optics, Imaging systems, diffraction, wave propagation	2	70%	65%
Outcome 2	Construct the realistic models using theory of propagation of light e.g., microscope and telescopes.	3	70%	65%
Outcome 3	Apply concepts of optics to solve numerical problems e.g., imaging using lens systems	3	65%	60%
Outcome 4	Examine the light modulation techniques using diffractive optical elements	4	55%	50%
Outcome 5	Device holography set-up for imaging and encryption applications holographic machines	5	65%	60%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2							2			2	2	1	1
Outcome 2	3	2		2					2			2	3	2	1
Outcome 3	3	3	2	1	2				2			2	3	1	2
Outcome 4	3	3	3	3	3				2			2	2	3	3
Outcome 5	3	3	2	3	3				2	2		3	2	3	3
Average	3.0	2.6	1.4	1.8	1.6				2.0	0.4		2.2	2.4	2.0	2.0

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References
Unit No. 1	Geometrical Optics	9	1, 3	
	Matrix Methods for Optical Components	1	1, 3	1, 2
	Imaging Using Mirrors and Lens	1	1, 3	1, 2
	Aberrations	1	1, 3	1, 2
	Radiometry and Photometry	1	3	1, 2
	Problem Solving – I	1	1, 3	1, 2
	Color Information and Color Display of Images	1	2, 3	1, 2
	Astronomical Telescope Using Two Convex Lenses	1	2, 3	1, 2
	Microscope	1	3	1, 2
	Problem Solving – II	1		1, 2
Unit No. 2	Diffraction	9	1, 3	
	Wave and Helmholtz Equations	1	1, 3	1, 2
	Kirchhoff's Formulation	1	1, 3	1, 2
	Angular Spectrum of Plane Waves	1	1, 3	1, 2
	Raileigh Somerfield Approximation	1	3	1, 2
	Problem Solving – III	1	1, 3	1, 2
	Huygens Fresnel Principle	1	1, 3	1, 2
	Fresnel and Franhoffer Approximation	1	1, 3	1, 2
	Diffraction through Grating and Aperture	1	3	1, 2
	Problem Solving – IV	1		1, 2
Unit No. 3	Wavefront Modulation	9	4	
	Modulation Using Photographic Film	1	4	1, 2
	Spatial Light Modulators (SLMs)	1	4	1, 2, 4
	Magento-optics SLMs	1	4	1, 2, 4
	Acousto-optic SLMs	1	4	1, 2
	Problem Solving - V	1	4	1, 2
	Modulation Transfer Function	1	4	1, 2, 4
	Binary Optics	1	4	1, 2
	Diffraction Optical Elements	1	4	1, 2
	Problem Solving – VI	1		1, 2
Unit No. 4	Optical Information Processing Systems	9	1, 4	
	Information Processing Systems: Coherent	1	1, 4	2, 3
	Information Processing Systems: Incoherent	1	4, 5	2, 3
	Joint Transform Correlator	1	4, 5	2, 3
	Mellin Correlators	1	4, 5	2, 3
	Problem Solving – VII	1	4, 5	2, 3
	Image Restoration	1	4, 5	2, 3
	Bragg Cell Spectrum Analyser	1	4, 5	2, 3
	Time Integrating Correlator	1	4, 5	2, 3
	Problem Solving – VIII	1		2, 3
Unit No. 5	Holography	9	5	
	Wavefront Recording and Reconstruction	1	5	2, 3
	Gabor Hologram	1	5	2, 3
	Practical Problems in Holography	1	5	2, 3
	Image Locations and Magnification	1	5	2, 3
	Fourier Holograms	1	5	2, 3
	Thick Holograms	1	5	2, 3
	Computer Generated Holograms	1	5	2, 3
	Holography with Incoherent Light	1	5	2, 3
	Problem Solving – IX	1	1, 3	2, 3
Total Contact Hours			45	

Course Unitization Plan - Project

SL. No.	Description of Experiment	Required Contact Hours	CLOs Addressed	References Used
1	Identify a project on modulating a amplitude and phase of light	6	4,5	1,2,3,4
2	Literature review	6	4,5	1,2,3,4
3	Device an experimental/simulation plan	6	4,5	1,2,3,4
4	Implement scheme using spatial light modulator	6	4,5	1,2,3,4
5	Obtain data, analyze and interpret the results	6	4,5	1,2,3,4
Total Contact Hours		30		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50 %)								End Semester Exam (50 %)	
		CLA-1 (15 %)		CLA-2 (15 %)		CLA-3 (_ %)		Mid Term (20 %)			
		Th	Proj	Th	Proj	Th	Prac	Th	Proj	Th	Proj
Level 1	Remember	20%		20%				10%		20%	
	Understand										
Level 2	Apply	30%	30%	30%	30%			30%	30%	30%	30%
	Analyse										
Level 3	Evaluate		20%		20%			10%	20%	10%	20%
	Create										
Total		50%	50%	50%	50%			50%	50%	50%	50 %

Recommended Resources

1. Goodman, J.W. (1996). Introduction to Fourier Optics, 2nd ed., New York: McGraw-Hill Book Company.
2. Khare, K. (2015). Fourier Optics and Computational Imaging, Hoboken: Wiley Publishers.
3. Hariharan, P. (2002). Basics of Holography, Cambridge: Cambridge University Press.
4. Tyson, R.K. (2014). Principles and Applications of Fourier Optics, Bristol: IOP Publishing

Other Resources

Artificial Intelligence in Complex Systems

Course Code	PHY 428	Course Category	CE				L	T	P	C
							3	1	0	4
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)						
Course Offering Department	Physics	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

1. To understand the fundamentals of artificial intelligence.
2. To apply algorithms to obtain accurate predictions using human efforts.
3. To apply algorithms using the environment.
4. To apply algorithms to obtain prediction with only input data using python.
5. To develop skills to write code in an efficient way.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Describe the statistical concepts of multidimensional data handling and their use in supervised and unsupervised learning	2	70%	65%
Outcome 2	Interpret overfitting and underfitting for classification and regression machine learning algorithms	3	70%	65%
Outcome 3	Categorize supervised-unsupervised, regression-classification learning algorithm use cases	4	70%	65%
Outcome 4	Investigate quantum and semiclassical systems using statistical learning algorithms	5	65%	60%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	3	3	3	2							2	3	1	2
Outcome 2	2	2	2	3	2	1			1	2		2	3	2	2
Outcome 3	2	3	3	3	3	2		1	2	1		3	3	2	2
Outcome 4	3	2	3	3	3	2		2	3	2		3	3	2	2
Average	2.3	2.5	2.8	3.0	2.5	1.7		1.5	2.0	1.7		2.5	3	1.8	2

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact hours	COs Addressed	Reference Used
Unit No. 1	Fundamentals of Artificial Intelligence	10		
	Introduction to Artificial Intelligence	1	1	1,3
	Learning Algorithms	1	1	1,3
	Tutorial: Classification of data sets and Regression	1	1,3	1,3
	Data sampling	1	1	1,3
	Tutorial: Density Estimation	1	1	1,3
	Performance Measure	1	1	1,3
	Experience	1	1	1,3
	Generalization, Overfitting and Underfitting	1	1,2	1,2
	Relation of Model Complexity to Dataset size	1	1,2	1,2
	Tutorial	1	1,2	1,2
Unit No. 2	Supervised Learning	14		
	Introduction to Supervised Learning	1	1	1,2
	Supervised Machine Learning Algorithms	1	1,3	1,2
	Sample Datasets	1	1,3	1,2
	k-Nearest Neighbors	1	3	1,2
	Linear Models	1	3	1,2
	Tutorial	1	1,3	1,2
	Naïve Bayes Classifiers	1	3	1,2
	Decision Trees and Examples	1	3	1,2
	Tutorial	1	1,3	1,2
	Uncertainty Estimates from Classifiers	1	3	1,2
	Predicting Probability	1	3	1,2
	Tutorial	1	1,3	1,2
	Discovery of physical laws by symbolic models	1	3	1,2
	Tutorial	1	3	1,2
Unit No. 3	Unsupervised Learning	14		
	Introduction to Unsupervised learning	1	1,3	1,2
	Algorithms	1	3	1,2
	Types of Unsupervised Learning	1	3	1,2
	Preprocessing and Scaling	1	3	1,2
	Data Transformations	1	3	1,2
	Tutorial	1	3	1,2
	Dimensional Reduction	1	1,3	1,2
	Feature Extraction	1	1,3	1,2
	Principal Component Analysis	1	1,3	1,2
	Tutorial	1	1,3	1,2
	Non-Negative Matrix Factorization	1	3	1,2
	k-Means Clustering	1	3	1,2
	Tutorial	1	3	1,2
	Agglomerative Clustering	1	3	1,2
Comparison and Evaluating Clustering Algorithms	1	3	1,2	
Unit No. 4	Applications-I	11		
	Density Matrix Formalism	1	1	1,2,3
	Reduced Density Matrix	1	1	1,2,3
	Tutorial	1	1	1,2,3
	Master equation of quantum systems	1	1,4	1,2,3

	Born approximation	1	4	1,2,3
	Markov approximation	1	4	1,2,3
	A master equation for a two-level system with decay	1	4	1,2,3
	Tutorial	1	1,4	1,2,3
	Lindblad equation	1	4	1,2,3
	Properties of Lindblad equation	1	4	1,2,3
	Tutorial	1	1,4	1,2,3
Unit No. 5	Applications-II	11		
	The Ising model	2	4	1,2,3
	Markov chains	2	1,4	1,2,3
	Tutorial	1	1,4	1,2,3
	Metropolis algorithm	1	4	1,2,3
	Gibbs sampling	2	4	1,2,3
	Tutorial	1	1,4	1,2,3
	Restricted Boltzmann machines for unsupervised learning.	2	4	1,2,3
Total Contact Hours		60		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (15%)		Mid-1 (20%)		CLA-2 (15%)				Th	Prac
		Th	Prac	Th	Prac	Th	Prac	Th	Prac		
Level 1	Remember	40%		60%		40%				30%	
	Understand										
Level 2	Apply	60%		40%		30%				50%	
	Analyse										
Level 3	Evaluate					30%				20%	
	Create										
Total		100%		100%		100%				100%	

Recommended Resources

1. Müller, A. C., & Guido, S. (2017). Introduction to Machine Learning with Python: A Guide for Data Scientists. Sebastopol, CA: O'Reilly Media.
2. Theobald, O. (2017). Machine Learning for Absolute Beginners.
3. Chandra, V. S. S. (2014). Artificial Intelligence and Machine Learning. New Delhi, India: PHI Learning.

Other Resources

1. NPTEL. (2020). Fundamentals of Artificial Intelligence. Retrieved from <https://archive.nptel.ac.in/noc/courses/noc20/SEM2/noc20-me88/>
2. MathWorks. (2020). Using Machine Learning to Model Complex Systems. Retrieved from <https://www.mathworks.com/videos/using-machine-learning-to-model-complex-systems-92916.html>

Physics of Finances

Course Code	PHY 429	Course Category	CE				L	T	P	C
							2	0	2	4
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)						
Course Offering Department	Physics	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

1. Framing financial markets as complex system
2. Outlining topological properties of financial networks
3. Using physics tools such as Geometric Brownian Motion to outline price dynamics

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Explain many-component interacting systems and their emergent properties in the context of elements of financial markets	2	70%	65%
Outcome 2	Illustrate the interacting topology in financial networks	3	70%	65%
Outcome 3	Analyze financial instruments and their behaviors using forms of Brownian motions	4	70%	65%
Outcome 4	Interpret price dynamics and option pricing using Geometric Brownian motion and Black-Scholes model	5	65%	60%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	2	2	2							2	2	3	1
Outcome 2	2	3	3	3	3	1		1	2	2		2	2	2	3
Outcome 3	2	3	3	3	3	2		1	2	2		3	2	3	3
Outcome 4	1	2	2	2	3	3		2	3	3		2	2	2	3
Average	2	2.8	2.5	2.5	2.8	2		1.3	2.3	2.3		2.3	2	2.5	2.5

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	COs Addressed	References Used
Unit No. 1	Financial markets and instruments	6		
	Types of financial markets (equity, debt, derivatives, etc.)	1	1	1,2
	Basic financial instruments (stocks, bonds, options, etc.)	1	1,3	1,2
	Basic concepts of options (call and put options)	1	1	1,2
	Payoff diagrams and terminology	1	1	1,2
	Data availability in real world markets	1	1,3	1,2
	The idea of Big data	1	1	1,2
Unit No. 2	Complex networks	6		
	Nodes, links and networks	1	1,2	3
	Network metrics: degree distribution, centrality, assortativity, and related measures	1	2	3
	Types of complex networks: Scale-free, small-world	1	2	3
	Erdos-Renyi and Barabasi-Albert networks	1	2	3
	Examples of small world networks in real world, Milgram's experiment	1	2	3
	Complex networks in financial systems	1	1,2	1,3
Unit No. 3	Complex systems and Financial markets	6		
	What is a complex system?	1	1	3
	Characteristics of complex systems	1	1	3
	Examples of complex systems in physics	1	1	3
	Critical behavior in complex systems	1	1	3
	Examples of complex systems outside of physics	1	1,2	3
	Framing financial systems as complex systems	1	2	3
Unit No. 4	Brownian motion and financial markets	6		
	Properties of Brownian motion	1	3	1,2
	Wiener processes	1	3	1,2
	Application of random walks in stock prices	1	1,3	1,2
	Geometric Brownian Motion (GBM); application to stock prices	1	1,3	1,2
	Drift, volatility	1	3	1,2
	Risk (measured by variance, standard deviation etc.), return	1	3	1,2
Unit No. 5	Option pricing and the Black-Scholes model	6		
	Basic option pricing concepts	1	4	1,2
	Binomial tree approach to option pricing; risk neutral valuation	1	4	1,2
	The Black-Scholes model: Assumptions	1	4	1,2
	The Black-Scholes model: Derivation steps	1	4	1,2
	Extensions and limitations of the Black-Scholes model; real world applications	1	4	1,2
	Future trends in financial market theory	1	4	1,2
Total contact Hours			30	

Course Unitization Plan: Project

S.No.	Description of Experiments	Required Contact hours	COs Addressed	References Used
1	Refinement of Idea	6		As recommended by the Advisor
2	Implement the Mathematical model	20		
	Optimize the mathematical model for the considered problem			
3	Conduct the simulation analysis and extract the results	20		
	Perform the experimental simulations.			
4	Validate the results obtained with Literature survey and presenting	14		
Total Contact Hours		60 hours		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50 %)								End Semester Exam (50 %)	
		CLA-1 (15 %)		CLA-2 (15 %)		CLA-3 (__ %)		Mid Term (20 %)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Project
Level 1	Remember	60%		40%			40%		20%		
	Understand										
Level 2	Apply	40%		60%			60%		30%	30%	
	Analyse										
Level 3	Evaluate									20%	
	Create										
Total		100%		100%			100%		50%	50%	

Recommended Resources

- Ziemann, V. (2021). Physics and Finance. Berlin/Heidelberg, Germany: Springer.
- Voit, J. (2005). The Statistical Mechanics of Financial Markets. Berlin/Heidelberg, Germany: Springer.
- Latora, V., Nicosia, V., & Russo, G. (2017). Complex Networks: Principles, Methods and Applications. Cambridge, UK: Cambridge University Press.

Other Resources

- Johnson, N. F., Jefferies, P., & Hui, P. M. (2003). Financial Market Complexity. Oxford, UK: Oxford University Press.
- NPTEL. (n.d.). Probability and Stochastics for Finance. Retrieved from https://onlinecourses.nptel.ac.in/noc22_ma26/preview

Game Theory: Classical and Quantum

Course Code	PHY 430	Course Category	CE				L	T	P	C
							2	0	2	4
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)						
Course Offering Department	Physics	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

1. Framing game theory as a complex system
2. Treating game theory examples with physics tools, particularly emergent phenomena
3. Describing real world examples of game theory applications such as biodiversity
4. Relate game theory to quantum mechanical effects

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Explain classical and quantum game theory framework within complex systems and its various applications such as evolutionary game theory	2	65%	70%
Outcome 2	Apply Nash equilibrium for game theory applications in physical, biological and other complex systems	3	65%	70%
Outcome 3	Interpret dominant actions in utilisation and biodiversity	3	65%	70%
Outcome 4	Analyze quantum effects in game theory models	5	65%	70%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	2	2	3	1		1	2	2		3	2	2	3
Outcome 2	3	2	3	3	3			2	3	3		3	2	1	3
Outcome 3	2	2	3	3	3	2		2	3	3		3	2	2	3
Outcome 4	3	3	3	2	3	2		2	3	3		3	3	2	3
Average	2.8	2.5	2.8	2.5	3	1.7		1.8	2.8	2.8		3	2.3	1.8	3

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	COs Addressed	References Used
Unit No. 1	Introduction to Classical Game theory	6		
	What is it and where it is applied?	1	1	1,2,3
	Strategic Thinking	1	1	1,2,3
	Definitions and terminology with simple examples: Prisoner's Dilemma and The Ultimate Game	1	1	1,2,3
	Non-cooperative versus Cooperative Games	1	1,3	1,2,3
	Games of perfect and imperfection information	1	1,3	1,2,3
	Zero-sum and Nonzero sum Games	1	1	1,2,3
Unit No. 2	Nash Equilibrium	6		
	Concepts and examples	1	2,3	1,2,3
	Dominated action	1	2	1,2,3
	Normal and Extensive Form Games	1	2	1,2,3
	Pure and mixed strategies	1	2,3	1,2,3
	Symmetry game & equilibria	1	2	1,2,3
	Multiple equilibria	1	2	1,2,3
Unit No. 3	Applications	6		
	Extensive games with perfect information	1	1,3	1,2,3
	Minority game: deterministic and stochastic strategies	1	1,3	1,2,3
	Emergence of cooperation	1	3	1,2,3
	Strategic decision making	1	3	1,2,3
	Biodiversity	1	3	1,2,3
	Game Theory and Physics	1	1,3	1,2,3
Unit No. 4	Evolutionary Game Theory (EGT)	6		
	Traditional/Static Games vs Evolutionary Games	1	2,3	1,2,3
	The Darwinian view of natural selection	1	3	1,2,3
	Evolutionary stable strategies with examples	1	3	1,2,3
	Relationship Between Evolutionary and Nash Equilibria	1	2,3	1,2,3
	Evolutionary mixed strategies with examples	1	3	1,2,3
	EGT and Engineering	1	3	1,2,3
Unit No. 5	Quantum Game Theory	6		
	A quick review of the relevant ideas: Superposition, Entanglement, Matrix mechanics	1	4	1,2,3
	Penny flip and Quantum 2 X 2 games	1	4	1,2,3
	Introductory ideas of Quantum game strategies	1	1,4	1,2,3
	Prisoner's Dilemma: Quantum version	1	2,4	1,2,3
	Co-operative and non-cooperative games	1	4	1,2,3
	Future directions in QGT	1	4	1,2,3
Total contact Hours			30	

Course utilisation plan: Project

S. No.	Description of Experiments	Required Contact hours	COs Addressed	References Used
1	Refinement of Idea	6		As recommended by the Advisor
2	Implement the Mathematical model	20		
	Optimize the mathematical model for the considered problem			
3	Conduct the simulation analysis and extract the results	20		
	Perform the experimental simulations.			
4	Validate the results obtained with Literature survey and presenting	14		
Total Contact Hours		60 hours		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50 %)								End Semester Exam (50 %)	
		CLA-1 (15 %)		CLA-2 (15 %)		CLA-3 (_ %)		Mid Term (20 %)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Project
Level 1	Remember	60%		40%			40%		20%		
	Understand										
Level 2	Apply	40%		60%			60%		30%	30%	
	Analyse										
Level 3	Evaluate									20%	
	Create										
Total		100%		100%			100%		50%	50%	

Recommended Resources

- Webb, J. N. (2007). Game Theory. Springer Undergraduate Mathematics Series. London: Springer. <https://doi.org/10.1007/978-1-84628-636-0>
- Osborne, M. J. (2012). An Introduction to Game Theory. 1st ed, Oxford: Oxford University Press. Retrieved from https://mathematicalolympiads.wordpress.com/wp-content/uploads/2012/08/martin_j-_osborne-an_introduction_to_game_theory-oxford_university_press_usa2003.pdf
- Dixit, A., & Nalebuff, B. (1991). Thinking Strategically: A Competitive Edge in Business, Politics, and Everyday Life. New York: W. W. Norton. Irvine, J. T. S., Sinclair, D. C., & West, A. R. (1990). Electroceramics: Characterization by Impedance Spectroscopy. *Advanced Materials, 2*(3), 132–138. <https://doi.org/10.1002/adma.19900020304>

Other Resources

- Hotz, H. (n.d.). Spieltheorie Handout. Retrieved from https://www.theorie.physik.uni-muenchen.de/lsfrey/teaching/archiv/sose_06/softmatter/talks/Heiko_Hotz-Spieltheorie-Handout.pdf
- Game Theory and Physics. (n.d.). Retrieved from <https://pubs.aip.org/aapt/ajp/article-abstract/73/5/405/1056134/Game-theory-and-physics?redirectedFrom=PDF>
- EGT. (n.d.). Game Theory and Evolutionary Biology. Retrieved from <https://www.ens-lyon.fr/DI/wp-content/uploads/2009/07/Chapter-28-Game-theory-and-evolutionary-biology.pdf>
- Wang, H. (n.d.). Quantum Game Theory. Retrieved from <http://math.uchicago.edu/~may/REU2022/REUPapers/Wang,Haoshu.pdf>

Battery Materials

Course Code	PHY 431	Course Category	CE			
			L	T	P	C
			3	0	1	4
Pre-Requisite Course(s)		Co-Requisite Course(s)	Battery Design & Testing; Beyond Li ion batteries	Progressive Course(s)		
Course Offering Department	Physics	Professional / Licensing Standards				

Course Objectives / Course Learning Rationales (CLRs)

1. To understand the basic concepts on electrochemistry.
2. To gain knowledge on various essential battery parameters.
3. To develop understanding of battery materials, working principle and construction of a Li-ion battery.
4. To enhance practical knowledge on various synthesis methods and characterization techniques on battery materials.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Identify the fundamental principles of electrochemistry and battery technology.	2	70%	65%
Outcome 2	Explain the key parameters and performance metrics of different battery types.	2	70%	65%
Outcome 3	Compare the role of known materials as cathode, anode and electrolytes on a Li-ion battery.	3	70%	65%
Outcome 4	Design experiments to synthesize and characterize battery materials.	4	65%	60%
Outcome 5	Evaluate and interpret data from characterization techniques such as XRD, FTIR, and SEM.	5	65%	60%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	1	1	2	2								3	1	1
Outcome 2	2	1	1	2	2							1	3	1	1
Outcome 3	2	2	1	3	3		1					2	2	2	1
Outcome 4	2	3	2	3	3	2	2		2	1		2	2	3	2
Outcome 5	2	3	2	3	3	3	2	2	3	2		2	2	3	3
Average	2.0	2.0	1.4	2.6	2.6	2.5	1.7	2.0	2.5	1.5		1.8	2.4	2.0	1.6

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Electrochemistry basics	9		
	Electrochemical cell	1	1,5	1,2,4
	Electrode potential and emf of a cell	1	1,5	1,2
	Measurement of electrode potential	1	1,5	1,2
	Standard hydrogen electrode	1	1,5	1,2
	Nernst equation	1	1,5	1,2
	Application of Nernst equation	1	1,5	1,2
	Thermodynamic behaviour of a cell: Gibb's free energy	1	1,5	1,2
	Thermodynamic behaviour of a cell; emf, enthalpy	1	1,5	1,2
	Numerical problems in electrochemistry	1	1,5	1,2
Unit No. 2	Battery parameters	9		
	Nominal voltage	1	1,2	1,2
	Specific capacity	1	1,2	1,2
	Energy density	1	1,2	1,2
	Power density	1	1,2	1,2
	Cycle life	1	1,2	1,2
	C - rate	1	1,2	1,2
	State of charge	1	1,2	1,2
	Performance characteristics	1	1,2,5	1,2
	Battery parameters of different commercial batteries	1	1,2	1,2
Unit No. 3	Li-ion battery	9		
	Construction	1	1,2	1,2
	Working principle	1	1,2	1,2
	Advantage	1	1,2	1,2
	Comparison with other metal-ion batteries	1	1,2	1,2
	Comparison with other energy storage devices such as fuel cells	1	1,2	1,2
	Comparison with other energy storage devices such as supercapacitor	1	1,2	1,2
	Applications of Li-ion batteries on different electronic devices	1	1,2	1,2
	Applications of Li-ion batteries in electric vehicles	1	1,2	1,2
	Prospects of Li-ion batteries	1	1,2	1,2
Unit No. 4	Battery materials for Li-ion batteries	9		
	An overview on various cathode materials known for Li-ion batteries	1	1,3	1,2
	Transition metal oxides such as LiCoO ₂ , NMC	1	3,4	1,2
	Spinel oxides such as LiMn ₂ O ₄	1	3,4	1,2
	Polyanionic materials such as LiFePO ₄	1	3,4	1,2
	An overview on various anode materials known for Li-ion batteries	1	3,4	1,2
	Carbon based materials such as graphite, hard carbon	1	3,4	1,2
	Oxide based materials	1	3,4	1,2
	Alloy based materials	1	3,4	1,2,3
	Electrolytes for Li-ion batteries	1	1,3,5	1,2,3
Unit No. 5	Synthesis and characterization of battery electrode materials	9		
	Synthesis: SSR, ball milling	1	4,5	1,2
	Synthesis: Hydrothermal, sol-gel	1	4,5	1,2
	Structural characterization: X-ray diffraction	1	4,5	1,2
	Structural characterization: FTIR	1	4,5	1,2,3
	Structural characterization: Raman spectroscopy	1	4,5	1,2,3
	Structural characterization: XPS	1	4,5	1,2,3
	Microstructural characterization: SEM	1	4,5	1,2,3
	Microstructural characterization: HRTEM	1	4,5	1,2,3
	Thermal characterization: DSC, TGA	1	4,5	1,2,3
Total Contact Hours			45	

Course Unitization Plan - Project

S. No.	Description of Experiment	Required Contact Hours	CLOs Addressed	References Used
1	Identify cathode and anode materials utilized in Li-ion battery	6	4,5	1,2,3
2	Literature review for synthesis procedure of the identified cathode and anode materials	6	4,5	1,2,3
3	Device an experimental plan	6	4,5	1,2,3
4	Synthesize cathode and anode materials using solid state route	6	4,5	1,2,3
5	Characterize using different techniques such as XRD, FTIR and Raman; Correlate with literature	6	4,5	1,2,3
Total Contact Hours		30		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50 %)								End Semester Exam (50 %)	
		CLA-1 (15 %)		CLA-2 (15 %)		CLA-3 (___%)		Mid Term (20 %)			
		Th	Proj	Th	Proj	Th	Prac	Th	Proj	Th	Proj
Level 1	Remember	20%		20%				20%		20%	
	Understand										
Level 2	Apply	30%	30%	30%	30%			30%	30%	30%	30%
	Analyse										
Level 3	Evaluate		20%		20%				20%		20%
	Create										
Total		50%	50%	50%	50%			50%	50%	50%	50 %

Recommended Resources

1. Winter. Abraham. Doughty. Ogumi. Zaghbi. Dudney. (2010). Rechargeable Lithium-Ion Batteries. Volume 25 (Issue 36), New Jersey USA: The electrochemical society. <https://www.proceedings.com/content/035/035618webtoc.pdf>
2. Korthauer, R. (Ed.). (2019). Lithium-Ion Batteries: Basics and Applications. Berlin/Heidelberg, Germany: Springer.
3. Cadex Electronics Inc. (2017). Batteries in a Portable World: A Handbook on Rechargeable Batteries for Non-Engineers (4th ed.). Place of publication: Cadex Electronics Inc.

Other Resources

1. NPTEL. (2021). Introduction to Electrochemistry. Source Link: <https://nptel.ac.in/courses/103/108/103108171/>
2. Bazant, M. Z. (2014). Electrochemical Energy Systems. MIT OpenCourseWare. Retrieved from MIT OCW: Electrochemical Energy Systems <https://ocw.mit.edu/courses/chemical-engineering/10-626-electrochemical-energy-systems-spring-2014/>

Battery Design and Testing

Course Code	PHY 432	Course Category	CE			
			L	T	P	C
			2	0	2	4
Pre-Requisite Course(s)	Solid State Physics	Co-Requisite Course(s)	Battery Design & Testing; Beyond Li ion batteries	Progressive Course(s)		
Course Offering Department	Physics	Professional / Licensing Standards				

Course Objectives / Course Learning Rationales (CLRs)

1. To learn various types of batteries from primary batteries to Li-ion batteries
2. To understand various cell configurations
3. To learn various techniques on the electrochemical characterization of batteries
4. To fabricate and characterize Li coin cell battery

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Identify the fundamental principles of electrochemical cells and battery types.	1	70%	65%
Outcome 2	Explain key parameters and performance metrics of primary and secondary batteries.	2	70%	65%
Outcome 3	Compare roles of cathode, anode, and electrolytes in Li-ion batteries.	4	70%	65%
Outcome 4	Design experiments to fabricate and characterize Li-ion batteries.	5	70%	65%
Outcome 5	Evaluate data from cyclic voltammetry, impedance spectroscopy, and charge-discharge studies.	5	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	1	1	2	2								3	1	1
Outcome 2	2	1	1	2	2							1	3	1	1
Outcome 3	2	2	1	3	3		1					2	2	2	1
Outcome 4	2	3	2	3	3	2	2		2	1		2	2	3	2
Outcome 5	2	3	2	3	3	3	2	2	3	2		2	2	3	3
Average	2.0	2.0	1.4	2.6	2.6	2.5	1.7	2.0	2.5	1.5		1.8	2.4	2.0	1.6

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact hours	CLOs Addressed	Reference Used
Unit No. 1	Battery types	10		
	Electrochemical cell	1	1	1,2
	Primary batteries; Dry Battery, Alkaline Battery, Li-MnO ₂ Battery	1	1	1,2
	Primary batteries; Advantages, Applications, Disadvantages	1	2	1,2
	Secondary Batteries: Advantages, Working principle	1	2	1,2
	Pb-Acid: Working principle	1	2	1,2
	Pb-Acid: Applications	1	2	1,2
	Redox flow batteries	1	2	1,2
	Ni-Cd Battery, Ni-Mn battery	1	2	1,2
	Reserve battery	1	2	1,2
	Li-ion battery: Historical development	1	2	1,2
Unit No. 2	Li-ion batteries - Construction	10		
	Li-ion batteries: Working principle and construction	1	2	1,2
	Materials for Li-ion batteries	1	3	1,2
	Battery characteristics; Specific capacity	1	2	1,2
	Battery characteristics: Energy density, power density, c-rate	1	2	1,2
	Coin cells, Cylindrical Cell	1	4	1,2
	Prismatic Cell	1	4	1,2
	Pouch Cell	1	4	1,2
	Cell in series	1	4	1,2
	Cell in parallel	1	4	1,2
	Battery Pack: Construction	1	4	1,2
Unit No. 3	Battery characterization techniques	10		
	Cyclic voltammetry: Working principle	1	5	1,2
	Cyclic voltammetry: Charge-discharge studies:	1	5	1,2
	Impedance Spectroscopy	1	5	1,2
	Impedance Spectroscopy: Interface studies	1	5	1,2
	Galvanostatic charge and discharge	1	5	1,2
	GCD: Cycle life, Rate studies	1	5	1,2
	Postmortem studies on batteries	1	5	1,2
	Battery characteristics of various cathode materials known on Li-ion batteries	1	3	1,2
	Battery characteristics of various anode materials known on Li-ion batteries	1	3	1,2
	Battery characteristics of full cells	1	3	1,2
Total Contact Hours			30	

Course Unitization Plan: Project

S. No.	Description of Experiment	Required Contact Hours	CLOs Addressed	References Used
1	Identify various electrolytes for Li-ion coin cell	12	3, 4	3, 4, 5
2	Literature review for fabrication and testing Li-ion coin cell	12	4	3, 4, 5
3	Fabrication of Li-ion batteries (coin cell)	12	4	3, 4, 5
4	Characterize the Li-ion coin cell	12	4, 5	3, 4, 5
5	Correlate experiment results with theory	12	5	3, 4, 5
Total Contact Hours			60	

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50 %)								End Semester Exam (50 %)	
		CLA-1 (15 %)		CLA-2 (15 %)		CLA-3 (_ %)		Mid Term (20 %)			
		Th	Proj	Th	Proj	Th	Prac	Th	Proj	Th	Proj
Level 1	Remember	20%		20%				20%		20%	
	Understand										
Level 2	Apply	30%	30%	30%	30%			30%	30%	30%	30%
	Analyse										
Level 3	Evaluate		20%		20%				20%		20%
	Create										
Total		50%	50%	50%	50%			50%	50%	50%	50 %

Recommended Resources

1. Cadex Electronics Inc. (2017). Batteries in a Portable World: A Handbook on Rechargeable Batteries for Non-Engineers (4th ed.). Place of publication: Cadex Electronics Inc.
2. Korthauer, R. (Ed.). (2019). Lithium-Ion Batteries: Basics and Applications. Berlin/Heidelberg, Germany: Springer.

Other Resources

1. Elgrishi, N., Rountree, K. J., McCarthy, B. D., et al. (2018). A practical beginner's guide to cyclic voltammetry. Journal of Chemical Education, 95(2), 197–206. Retrieved from <https://www.proceedings.com/content/035/035618webtoc.pdf>
2. Kim, T., Choi, W., Shin, H. C., et al. (2020). Applications of voltammetry in lithium ion battery research. Journal of Electrochemical Science and Technology, 11(1), 14–25. <https://doi.org/10.20964/2020.01.02>
3. NPTEL. (2024). Battery Cell Technology: Materials and Industrial Applications. Retrieved from <https://elearn.nptel.ac.in/shop/iit-workshops/completed/battery-cell-technology-materials-and-industrial-applications/?v=c86ee0d9d7ed>

Course Designers

Beyond Li-ion batteries

Course Code	PHY 433	Course Category	CE				L	T	P	C
							2	0	2	4
Pre-Requisite Course(s)	Solid State Physics	Co-Requisite Course(s)	Battery Design & Testing; Battery Materials	Progressive Course(s)						
Course Offering Department	Physics	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

1. To know the drawbacks of the present generation Li-ion batteries.
2. To understand the need for all-solid-state batteries and their advantages and challenges.
3. To understand the working principle of Na-ion batteries and their challenges.
4. To learn an overview on various batteries relying on beyond Li and Na chemistries.
5. To learn an overview on various batteries relying on the anion chemistries.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Explain the advantages, and drawbacks towards the industrial aspects of Li-ion batteries.	2	70%	65%
Outcome 2	Classify various metal-ion and anion batteries, including their chemistries and performance metrics.	2	70%	65%
Outcome 3	Analyze the construction, working principles, and materials of all-solid-state batteries.	4	65%	60%
Outcome 4	Compare Na-ion batteries and their electrochemical performance with current technologies.	4	65%	60%
Outcome 5	Design experiments to synthesize, characterize, and evaluate battery materials using various techniques.	5	65%	60%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	1	1	2	2								3	1	1
Outcome 2	2	1	1	2	2							1	3	1	1
Outcome 3	2	2	1	3	3		1					2	2	2	1
Outcome 4	2	3	2	3	3	2	2		2	1		2	2	3	2
Outcome 5	2	3	2	3	3	3	2	2	3	2		2	2	3	3
Average	2.0	2.0	1.4	2.6	2.6	2.5	1.7	2.0	2.5	1.5		1.8	2.4	2.0	1.6

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact hours	CLOs Addressed	Reference Used
Unit No. 1	Li-ion batteries; Challenges	10		
	Li-ion batteries: Advantages	1	1, 4	1,2
	Li-ion batteries: Applications	1	1	1,2
	Challenges of the present generation Li-ion batteries	1	1, 4	1,2
	Recycling of the spent Li-ion batteries	1	1, 4	1,2
	Overview on various metal ion batteries; Na, K, Mg	1	2, 4	1,2
	Overview on various metal ion batteries; Ca, Al, Zn	1	2, 4	1,2
	Overview on various anion batteries: F	1	2, 4	1,2
	Overview on various anion batteries: Cl	1	2, 4	1,2
	Overview on all-solid-state batteries	1	2, 3	1,2
	Comparison of various battery chemistries	1	2, 3, 4	1,2
Unit No. 2	All-Solid-State batteries	10		
	Difference between conventional and all-solid-state batteries	1	3	1,2
	Advantage of all-solid-state batteries	1	3	1,2
	Solid electrolytes and their classifications	1	3	1,2
	Inorganic solid electrolytes	1	3	1,2
	Glassy solid electrolytes	1	3	1,2
	Polymer electrolytes	1	3	1,2
	Composite electrolytes	1	3	1,2
	All-solid-state batteries: Construction and working principle	1	3	1,2
	All-solid-state batteries: Challenges	1	3	1,2
	All-solid-state batteries: Future goals		3	
Unit No. 3	Na-ion batteries	10		
	Na-ion batteries: Working principle and construction	1	4	1,2
	Na-ion batteries: Advantages	1	4	1,2
	Cathode materials known for Na-ion batteries	1	4, 5	1,2
	Liquid electrolytes known for Na-ion batteries	1	4, 5	1,2
	Solid electrolytes known for Na-ion batteries	1	4, 5	1,2
	Anode materials known for Na-ion batteries	1	4, 5	1,2
	Electrochemical performance of various Na-ion full cells known	1	4	1,2
	Industrial prospects of Na-ion batteries	1	4	1,2
	Challenges of Na-ion batteries	1	4	1,2
	Roadmap for the futuristic Na-ion batteries	1	4	1,2
Total Contact Hours			30	

Course Unitization Plan – Project

S. No.	Description of Experiments	Required Contact Hours	CLOs Addressed	References Used
1	Identify cathode and anode materials utilized in Na-ion battery	12	4, 5	3
2	Literature review for synthesis procedure of the identified cathode and anode materials	12	4, 5	3,4
3	Device an experimental plan	12	5	3
4	Synthesize the materials in laboratory	12	5	3
5	Characterize using different techniques such as XRD, FTIR and Raman; Correlate with literature	12	5	3
6	Fabricate and characterize Na-ion battery coin cell	12	5	3
Total Contact Hours			60	

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50 %)								End Semester Exam (50 %)	
		CLA-1 (15 %)		CLA-2 (15 %)		CLA-3 (___ %)		Mid Term (20 %)			
		Th	Proj	Th	Proj	Th	Prac	Th	Proj	Th	Proj
Level 1	Remember	20%		20%				20%		20%	
	Understand										
Level 2	Apply	30%	30%	30%	30%			30%	30%	30%	20%
	Analyse										
Level 3	Evaluate		20%		20%				20%		30%
	Create										
Total		50%	50%	50%	50%			50%	50%	50%	50%

Recommended Resources

1. Buchmann, I. (2016). Batteries in a Portable World: A Handbook on Rechargeable Batteries for Non-Engineers (4th ed.). Cadex Electronics Inc.
2. Sunandana, C. S. (2015). Introduction to Solid State Ionics. CRC Press.
3. García, B. (Ed.). (2022). Sodium Ion Batteries: Energy Storage Materials and Technologies. Wiley.
4. NPTEL. (n.d.). Advanced Battery Technologies. Retrieved from <https://elearn.nptel.ac.in/shop/iit-workshops/completed/battery-cell-technology-materials-and-industrial-applications/?v=c86ee0d9d7ed>

Other Resources

Quantum Computation: Background and Formulation

Course Code	PHY 437	Course Category	CE				L	T	P	C
							3	1	0	4
Pre-Requisite Course(s)	PHY 213	Co-Requisite Course(s)		Progressive Course(s)						
Course Offering Department	Physics	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

1. To understand the advanced applications of quantum mechanical phenomena such as entanglement.
2. To understand various quantum communication protocols
3. To understand the mathematical foundation of quantum bits and various quantum gates.
4. To implement quantum Fourier transform using quantum gates.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Understand the quantum mechanical framework of quantum computing, and related phenomena such as entanglements	2	70%	65%
Outcome 2	Illustrate qubits, and the effect of quantum gates on them	3	70%	65%
Outcome 3	Examine quantum entanglement in the context of making entangled states and their use for quantum communication	4	70%	65%
Outcome 4	Employ the quantum gates in quantum circuits	4	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	3	2	2							2	3	1	2
Outcome 2	3	3	3	2	3			1				3	3	2	1
Outcome 3	3	3	2	3	3	1		1	2	2		2	3	2	2
Outcome 4	3	3	2	3	3	1		2	2	2		2	3	2	2
Average	3	3	2.5	2.5	2.8	1		1.5	1.7	2		2.3	3	1.8	1.8

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	COs Addressed	References
Unit No. 1	Mathematical foundations of quantum computation	12		
	Postulates of quantum mechanics	1	1	1, 2, 3
	Basis vectors	1	1	1, 2, 3
	Tutorial: Linear vector space and its properties	1	1	1, 2, 3
	Orthogonality	1	1	1, 2, 3
	Hilbert space	1	1	1, 2, 3
	Tutorial: Superposition principle	1	1	1, 2, 3
	Inner and outer products	1	1	1, 2, 3
	Solved examples: Inner and outer products	1		1, 2, 3
	Hermitian operators	1	1	1, 2, 3
	Unitary operators	1	1	1, 2, 3
	Matrix representation of operators	1	1	1, 2, 3
	Solved examples: Matrix representation of operators	1		1, 2, 3
Unit No. 2	Elementary units of quantum computation	12		
	Classical computers and their limitations	1	1,2	3,4,5
	Introduction to quantum computation	1	1,2	3,4,5
	Single qubit and its representation in matrix	1	2	3,4,5
	Bloch sphere	1		3,4,5
	Multiple qubits (two qubits, three qubits)	1	2	3,4,5
	Two-qubit entanglement and examples	1	2	3,4,5
	Tutorial: Two-qubit entanglement	1	2,3	3,4,5
	Quantification of entanglement	1		3,4,5
	Applications of entanglement	1	2,3	3,4,5
	Three qubit entanglement and examples	1	2	3,4,5
	Tutorial: Three qubit entanglement	1		3,4,5
	Problem solving on quantum entanglement	1		3,4,5
Unit No. 3	Quantum communications	12		
	Bell states	1	1,3	3,4,5
	Einstein-Podolsky-Rosen Paradox	1	3	3,4,5
	Tutorial: Bell states	1	2,3	3,4,5
	Quantum teleportation	1	2,3	3,4,5
	Role of entanglement on quantum teleportation	1		3,4,5
	Tutorial: Entanglement on quantum teleportation	1	2,3	3,4,5
	Basic ideas on quantum key distribution	1	3	3,4,5
	Quantum dense coding	1	3	3,4,5
	Quantum state transfer	1		3,4,5
	No cloning theorem	1	2,3	3,4,5
	Tutorial: No cloning theorem	1	3	3,4,5
	Solved Examples	1		3,4,5
Unit No. 4	Quantum gates	12		
	Quantum gates vs classical gates	1	2	3,4,5
	Pauli gates and their operations on qubits	1	2	3,4,5
	Hadamard gate, square-root NOT gate	1	2	3,4,5
	Tutorial: Various Gates and operation	1		3,4,5
	Single qubit phase gates	1	2	3,4,5
	CNOT gate	1	2	3,4,5
	Entangling and de-entangling of qubits using CNOT gates	1	2,4	3,4,5
	Tutorial: Entangling and de-entangling of qubits using CNOT gates	1		3,4,5
	Controlled phase gates	1	2,4	3,4,5
	Swap gates	1	2,4	3,4,5
	Tutorial: phase gates and swap gates	1	2,4	3,4,5
	Solved Examples	1		3,4,5
	Quantum circuits	12		
	Circuit representation of quantum gates	1	2,4	3,4,5

Unit No. 5	Measurement theory	1	2,4	3,4,5
	Circuit representation of measurement theory	1	2,4	3,4,5
	Tutorial: Circuit representation of measurement theory	1		3,4,5
	Quantum circuit of two qubits swapping	1	2,4	3,4,5
	Quantum circuit of two qubits swapping	1	4	3,4,5
	Tutorial: Quantum circuit for two-qubit copying	1	4	3,4,5
	Quantum parallelism	1		3,4,5
	Quantum Fourier transformation	1	4	3,4,5
	Circuit for quantum Fourier transformation	1	4	3,4,5
	Tutorial: quantum Fourier transformation	1	2,3,4	3,4,5
	Problem solving	1		3,4,5
Total Contact Hours		60		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50 %)								End Semester Exam (50 %)	
		CLA-1 (15 %)		CLA-2 (15 %)		CLA-3 (_ %)		Mid Term (20 %)		Th	Prac
		Th	Prac	Th	Prac	Th	Prac	Th	Prac		
Level 1	Remember	60%		40%				40%		30%	
	Understand										
Level 2	Apply	40%		60%				60%		70%	
	Analyse										
Level 3	Evaluate										
	Create										
Total		100%		100%				100%		100%	

Recommended Resources

1. Zettili, N. (2009). Quantum Mechanics: Concepts and Applications. Wiley.
2. Griffiths, D. J. (1995). Introduction to Quantum Mechanics. Prentice Hall.
3. Nielsen, M. A., & Chuang, I. L. (2000). Quantum Computation and Quantum Information. Cambridge University Press.
4. Kaye, P., Laflamme, R., & Mosca, M. (2007). An Introduction to Quantum Computing. Oxford University Press.
5. Pathak, A. (2013). Elements of Quantum Computation and Communication. Taylor and Francis Group.

Other Resources

Quantum Computation and Algorithms

Course Code	PHY 438	Course Category	CE				L	T	P	C
							3	0	1	4
Pre-Requisite Course(s)	PHY 213, PHY 316	Co-Requisite Course(s)		Progressive Course(s)						
Course Offering Department	Physics	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

1. To understand various quantum algorithms and their potential applications.
2. To understand the quantum Fourier transform and quantum key distribution.
3. To experience the working of IBM quantum computer and its uses.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Explain the qubits, quantum entanglement and quantum gates	2	70%	65%
Outcome 2	Interpret the action of the quantum gates on qubits	3	70%	65%
Outcome 3	Employ quantum gates to build quantum circuits for entangled qubits and examine through IBM computer	4	70%	65%
Outcome 4	Interpret quantum algorithms and concept of quantum key distribution	4	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	3	3	2				2			2	3	1	2
Outcome 2	3	3	3	2	3				2			3	3	2	1
Outcome 3	3	3	3	3	3	3		1	2	2		2	3	2	2
Outcome 4	3	3	3	3	3			1	2	2		2	3	2	2
Average	3	3	3	2.8	2.8	3		1	2	2		2.3	3	1.8	1.8

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	COs Addressed	References
Unit No. 1	Elementary units for quantum computation	9	1	
	Pre-requisite ideas of quantum mechanics for quantum computation	1	1	1, 2, 3
	Introduction to quantum computation	1	1	1, 2, 3
	Single qubit and its representation in matrix and Bloch sphere	1	1	1, 2, 3
	Multiple qubits (two qubits, three qubits)	1	1	1, 2, 3
	Two-qubit entanglement	1	1	1, 2, 3
	Multi-qubit entanglement	1	1	1, 2, 3
	Quantification of entanglement	1	1	1, 2, 3
	Applications of entanglement	1	1,3	1, 2, 3
	Tutorial/ Doubt clearing	1	1,3	1, 2, 3
Unit No. 2	Quantum Gates	9	2	
	Pauli Gates and Phase gates, and their operations on qubits	1	2	1, 2, 3
	Hadamard gate	1	2	1, 2, 3
	CNOT gate	1	2	1, 2, 3
	Controlled phase-shift gate	1	2	1, 2, 3
	Swap gate	1	2	1, 2, 3
	Toffoli gate	1	2	1, 2, 3
	Fredkin gate (controlled Swap gate)	1	2	1, 2, 3
	Combination of Gates	1	2,3	1, 2, 3
	Tutorial/ Doubt clearing	1	2,3	1, 2, 3
Unit No. 3	Quantum circuits	9		
	Circuit representation of two-qubit and three-qubit gates	1	2,3	1, 2, 3
	Quantum measurement in quantum circuit	1	3	1, 2, 3
	Quantum circuits for swapping and copying	1	3	1, 2, 3
	EPR circuit	1	3	1, 2, 3
	Building quantum circuit of Toffoli gate using two qubit gates	1	3	1, 2, 3
	Building quantum circuit of Fredkin gate	1	2,3	1, 2, 3
	Quantum circuits for Hamiltonian evolution	1	2,3	1, 2, 3
	Quantum parallelism	1	3	1, 2, 3
	Tutorial/ Doubt clearing	1	3	1, 2, 3
Unit No. 4	Quantum Algorithm, Key Distribution	9		
	Quantum Fourier Transformation (QFT)	1	3,4	1, 2, 3
	Deutsch algorithm	1	4	1, 2, 3
	Deutsch-Josza algorithm	1	4	1, 2, 3
	Shor's Algorithm	1	4	1, 2, 3
	Tutorial/Doubt clearing	1	3,4	1, 2, 3
	Introduction to Quantum key distribution	1	4	1, 2, 3
	BB84 protocol	1	4	1, 2, 3
	BB92 protocol	1	4	1, 2, 3
	Tutorial/ Doubt clearing	1	3,4	1, 2, 3
Unit No. 5	Quantum computation in IBM quantum computer	9		
	Introduction to the cloud-based IBM quantum computer	1	1,4	1, 2, 4
	Demonstration quantum computation on IBM quantum computer	1	4	1, 2, 4
	Single-qubit gates in IBM	1	1,4	1, 2, 4
	Two-qubit gates in IBM	1	1,4	1, 2, 4
	Realization of various 2 qubit gates using fundamental single and two-qubit gates	1	4	1, 2, 4
	Experiencing IBM Kit by students – single qubit quantum gates	1	4	1, 2, 4
	Experiencing IBM Kit by students – two-qubit quantum gates	1	4	1, 2, 4
	Experiencing IBM Kit by students – quantum algorithms	1	4	1, 2, 4
	Tutorial/ Doubt clearing	1	1,4	1, 2, 4
Total Contact Hours			45	

Course Assessment: Project

S. No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
1	Identify a project problem involving IBM quantum computer on quantum information, quantum algorithms, protocols, quantum gates etc	6	3,4	4
2	Literature review	6	3,4	4
3	Device a simulation/experimental plan	6	3,4	4
4	Extract and analysis the results	6	3,4	4
5	Validate the results, interpret with literature survey	6	3,4	4
Total Contact Hours		30		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50 %)								End Semester Exam (50 %)	
		CLA-1 (15 %)		CLA-2 (15 %)		CLA-3 (___%)		Mid Term (20 %)			
		Th	Proj	Th	Proj	Th	Prac	Th	Proj	Th	Proj
Level 1	Remember	20%		20%				20%		20%	
	Understand										
Level 2	Apply	30%	50%	30%	50%			30%	50%	30%	50%
	Analyse										
Level 3	Evaluate										
	Create										
Total		50%	50%	50%	50%			50%	50%	50%	50%

Recommended Resources

1. Nielsen, M. A., & Chuang, I. L. (2000). Quantum Computation and Quantum Information. Cambridge University Press.
2. Kaye, P., Laflamme, R., & Mosca, M. (2007). An Introduction to Quantum Computing. Oxford University Press.
3. Pathak, A. (2013). Elements of Quantum Computation and Communication. Taylor and Francis Group.
4. IBM. (n.d.). IBM Qiskit. Retrieved from <https://quantum.ibm.com/composer>

Other Resources

Quantum Optimization and Quantum Computation

Course Code	PHY 439	Course Category	CE				L	T	P	C
							3	0	1	4
Pre-Requisite Course(s)	PHY 213	Co-Requisite Course(s)		Progressive Course(s)						
Course Offering Department	Physics	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

- To understand the concept of combinatorial optimizations problem and the usefulness of quantum annealing in those problems.
- To apply the concepts of quantum annealing in model systems.
- To understand physical principles, hardwares and challenges of implementation of quantum computers

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Understand multivariable optimisation process and physical realisations of quantum computers	2	70%	65%
Outcome 2	Apply quantum annealing to simple physics models	3	70%	65%
Outcome 3	Analyze quantum annealer performance and challenges	4	70%	65%
Outcome 4	Interpret the performance benchmarking and trajectory towards quantum supremacy and beyond	4	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	2	3	3	3							3	2	1	3
Outcome 2	3	3	3	2	3			1	2	2		3	2	2	3
Outcome 3	2	2	3	3	3	2		1	2	2		3	2	2	3
Outcome 4	2	2	2	3	3	2		1	2	2		3	2	3	3
Average	2.3	2.3	2.8	2.8	3.0	2.0		1.0	2.0	2.0		3.0	2.0	2.0	3.0

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	COs Addressed	References
Unit No. 1	Quantum annealing: Background	9		
	Combinatorial optimisation problems	1	1	1,2
	Idea of complexity in optimisation problems	1	1	1,2
	The Traveling Salesman Problem (TSP) and its complexity	1	1	1,2
	Tutorial: Combinatorial optimisation problems	1	1	1,2
	Idea of thermal annealing	1	1	1,2
	Simulated annealing	1	1	1,2
	Tutorial: Simulated annealing			1,2
	Challenges in simulated annealing for complex problems	1	1,3	1,2
	Tutorial/ Doubt clearing	1	1,3	1,2
Unit No. 2	Quantum annealing: Models and applications	9		
	Barrier tunneling in quantum mechanics: Square well and delta function barriers	1	2	2,3,4
	Adiabatic theorem and its application to quantum annealing	1	2	2,3,4
	From initial to final Hamiltonian in quantum annealing	1	2	2,3,4
	Tutorial on adiabatic theorem	1	2	2,3,4
	Transverse field Ising model	1	2	2,3,4
	Quantum annealing in transverse field Ising model	1	2	2,3,4
	Tutorial on transverse Ising model	1	2,3	2,3,4
	Quantum annealing in chemistry and materials science (examples)	1	2,3	2,3,4
Tutorial/ Doubt clearing	1	2,3	2,3,4	
Unit No. 3	Quantum annealing hardware	9		
	Challenges in quantum annealing hardware design	1	1	3,4
	Thermal noise, quantum decoherence	1	1	3,4
	Tutorial on quantum decoherence	1	1	3,4
	D-wave architecture	1	1	3,4
	Current state and scaling up	1	1,4	3,4
	Benchmarking quantum annealer performances	1	1,4	3,4
	Tutorial on quantum annealer performance	1	1,4	3,4
	Integration of quantum annealing processors with classical systems	1	4	3,4
Tutorial/ Doubt clearing	1	4	3,4	
Unit No. 4	Quantum computers: Physical realisations	9		
	Josephson junctions, Superconducting circuits (ex: IBM machine)	1	1	3,4
	Method of trapped ions (ex: Honeywell Quantum solutions)	1	1	3,4
	Tutorial on ion trapping methods	1	1,3	3,4
	Topological qubits (ex: Microsoft)	1	1	3,4
	Photonic quantum computers (ex: Xanadu)	1	1	3,4
	Tutorial on topological qubits	1	1,3	3,4
	Quantum dots (Ex: Intel)	1	1	3,4
	Optical lattice (Ex: ColdQuanta)	1	1	3,4
Tutorial/ Doubt clearing	1	1,3	3,4	
Unit No. 5	Quantum computations: Future directions	9		
	Quantum supremacy and beyond	1	4	3,4
	Idea of quantum error corrections and fault tolerance	1	3,4	3,4
	Tutorial on quantum error corrections	1	4	3,4
	Hybrid classical-quantum systems	1	4	3,4
	Quantum internet	1	4	3,4
	Expansion to various industries (pharma, finance, materials design etc.)	1	4	3,4
	Tutorial on industry applications	1	3,4	3,4
	Tutorial/ Doubt clearing	1	4	3,4
Overall outlook	1	4	3,4	
	Total Contact Hours		45	

Course Unitization Plan: Project

S.No.	Description of Experiments	Required Contact Hours	CLOs Addressed	References Used
1	Identify a project on combinatorial optimization problem, quantum annealing in model systems, physical mechanisms behind quantum computers	6	3,4	5,6
2	Literature review	6	3,4	5,6
3	Device a simulation/experimental plan	6	3,4	5
4	Extract and analysis the results	6	3,4	5
5	Validate the results with literature survey	6	3,4	5
Total Contact Hours		30		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50 %)								End Semester Exam (50 %)	
		CLA-1 (15 %)		CLA-2 (15 %)		CLA-3 (___ %)		Mid Term (20 %)			
		Th	Proj	Th	Proj	Th	Prac	Th	Proj	Th	Proj
Level 1	Remember	20%		20%				20%		20%	
	Understand										
Level 2	Apply	30%	50%	30%	50%			30%	50%	30%	50%
	Analyse										
Level 3	Evaluate										
	Create										
Total		50%	50%	50%	50%			50%	50%	50%	50%

Recommended Resources

1. Papadimitriou, C. H., & Steiglitz, K. (1998). Combinatorial Optimization: Algorithms and Complexity. New York: Dover Publications.
2. Suzuki, S., Inoue, J., & Chakrabarti, B. K. (2012). Quantum Ising phases and transitions in transverse Ising models, 2nd ed. Berlin: Springer. ISSN: 0075-8450.
3. Nielsen, M. A., & Chuang, I. L. (2000). Quantum Computation and Quantum Information. Cambridge: Cambridge University Press.
4. McGeoch, C. C. (2014). Adiabatic Quantum Computation and Quantum Annealing: Theory and Practice. San Rafael: Morgan & Claypool Publishers. ISSN: 978-3-031-01390-4.
5. NPTEL. (n.d.). Quantum computing. Retrieved from <https://elearn.nptel.ac.in/shop/iit-workshops/completed/quantum-computing/?v=c86ee0d9d7ed>
6. YouTube. (n.d.). Quantum Computing: Explained with a deck of cards. Retrieved from <https://www.youtube.com/watch?v=H9f7XHCHNxc>

Other Resources

Introduction to R and Python

Course Code	SEC 501	Course Category	SEC				L	T	P	C
			1	1	1	3				
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)						
Course Offering Department	Mathematics	Professional / Licensing Standards								

Course Objectives / Course Learning Rationales (CLRs)

1. In Python, identify and describe essential elements such as syntax, keywords, variables, indentation, data types, lists, tuples, sets, dictionaries, operators, control statements, and loops.
2. Understand the significance of built-in functions, user input-output, matrix computations, linear equations, and graphing curves and surfaces using Matplotlib and file handling in Python.
3. Implement R programming fundamentals, including objects, vectors, matrices, arrays, data manipulation techniques (subsetting, filtering, merging), and data frames, and create visualisations using ggplot2 in R.
4. Synthesise knowledge from Python and R to perform comprehensive data analysis and create reports that include descriptive statistics, linear regression, hypothesis testing, and time series forecasting.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Demonstrate an understanding of Python programming fundamentals, including syntax, keywords, variables, data types, lists, tuples, sets, dictionaries, operators, and control statements.	2	80	70
Outcome 2	Grasp core programming concepts by comprehending the role of built-in functions, user input-output, file handling and graphing curves and surfaces using Matplotlib in Python.	3	75	70
Outcome 3	Apply programming skills in R by effectively using objects, vectors, matrices, arrays, and data frames, and will demonstrate the practical application of data manipulation techniques, including sub-setting, filtering, and merging, and create visualizations using ggplot2 in R.	4	75	70
Outcome 4	Integrate Python and R knowledge to perform sophisticated data analysis that incorporates descriptive statistics, linear regression, hypothesis testing, and time series forecasting, showcasing a synthesis of programming skills across both languages.	4	75	70
Outcome 5	Demonstrate an understanding of Python programming fundamentals, including syntax, keywords, variables, data types, lists, tuples, sets, dictionaries, operators, and control statements.	2	80	70

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Life Long Learning	PSO 1	PSO 2
Outcome 1	3	3	3	3				1			2	3	1	2
Outcome 2	3	3	3	2	1			2			2	3	2	2
Outcome 3	3	3	3	3	1			2			2	3	2	2
Outcome 4	3	3	3	3	3			3			2	3	2	2
Outcome 5	3	2	3	3	3			2			3	2	2	2
Average	3	3	3	3	2			2			2	3	2	2

Course Unitization Plan Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1		6		
	Introduction to data and its different types of scales.	3	1,2	1
	Summarising data, different types of descriptive statistics	3	1,2	1
Unit 2		9		
	Introduction to Vectors, matrices	3	2,3	1
	Recursive functions, Matrix computations and linear equations	3	2,3	1
	Solving system of Linear Equations. Consistency, transpose, determinants, inverses, trace,	3	2,3	1
Unit 3		15		
	Basic principles of probability, Random variables.	2	3,4	2
	The Binomial, Normal and other popular distributions.	2	3,4	2
	Inference for one or two samples means using the t-distribution, statistical power for comparing two groups	2	3,4	2
	Introduction to Correlation Analysis, Correlation coefficient for Categorical and Continuous data.	2	4	2
	Introduction to the logistics regression.	4	4	2
Total Contact Hours			30	

Course Unitization Plan Lab

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
1	Write a program to demonstrate the use of Python syntax, keywords, and variables.	2	1	1
2	Create a program that uses indentation and comments to improve code readability.	2	1	1
3	Implement a program that showcases different data types in Python (int, float, string, Boolean).	2	1	1
4	Write a program that manipulates lists (e.g., sorting, appending, slicing).	2	1	1
5	Create a program that demonstrates using tuples and sets in Python.	2	2	1
6	Implement a dictionary to store and retrieve information.		2	1
7	Write a program that uses different operators in Python (+, -, *, /, //, %, **).	2	2	1
8	Create a program that includes control statements (if-else, nested if-else, switch-case) and loops (for, while).	2	2	1
9	Write a program to create and manipulate objects in R.	2	3	2
10	Implement a program that demonstrates using vectors and matrices in R.	2	3	2
11	Create a program that works with arrays and lists in R.	2	3	2
12	Write a program to handle missing data in a data frame.	2	3	2
13	Implement a program that reads and writes data to CSV or text files.	2	4	2
14	Create a program that performs data manipulation tasks (subsetting, filtering, merging) on a data frame.	2	4	2
15	Write a program that uses ggplot2 to create a plot in R.	2	3,4	2
Total Contact Hours		30		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (60%)								End Semester Exam (40%)	
		CLA-1 20%		Mid-1 20%		CLA-2 10%		CLA-3 10%			
		Th	Pr	Th	Pr	Th	Pr	Th	Pr	Th	Pr
Level 1	Remember	35%	40%	20%	20%	30%	15%	25%		20%	15%
	Understand	35%	40%	20%	20%	30%	15%	25%		20%	15%
Level 2	Apply	15%	10%	20%	20%	20%	20%	25%		25%	25%
	Analyse	15%	10%	20%	20%	20%	20%	25%		25%	25%
Level 3	Evaluate			10%	10%		15%			5%	10%
	Create			10%	10%		15%			5%	10%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Recommended Resources

1. Guido van Rossum and the Python development team Python Tutorial Release 3.7.0.
2. W. N. Venables, D. M. Smith and the R Core Team, An Introduction to R
3. R in Action, Robert L. Kabacoff, Second Edition, Paperback, Dreamtech Press
4. A Beginner's Guide to R, Alain F. Zuur, Elena N. Ieno, Erik H. W. G. Meesters, Springer New York.
5. The Absolute Beginner's Guide to Python Programming, A Step-by-Step Guide with Examples and Lab Exercises, Kevin Wilson, Apress Berkeley, CA
6. Python Programming Fundamentals, Kent D. Lee, Springer London

Other Resources