Department of Physics

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

(Applicable to the students admitted during AY: 2022-23)

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

Department Vision

To create a vibrant centre of academic excellence and interdisciplinary research, aimed at inspiring the next generation of physicists to serve society through interactive learning, fundamental research, industry partnerships, and academic collaborations.

Department Mission

1. Deliver a curriculum that provides a modern understanding of laws and extensive exposure to teaching and research laboratories, fulfilling industry needs.
2. Create a research and innovation hub equipped with world class facilities to make a lasting impact towards fundamental discoveries and translational research.
3. Cultivate an atmosphere to identify and address problems aligned with national and societal needs.

Program Educational Objectives (PEO)

1. Equip graduates with a deep understanding of fundamental and advanced physics principles, enabling them to integrate modern knowledge and practical skills to meet demands of academic and industry careers.
2. Develop skills in utilizing advanced teaching and research laboratories, enabling graduates to design experiments, analyze data, and apply findings in real-world contexts.
3. Foster problem-solving abilities and innovative thinking among graduates to tackle national and societal challenges, promoting sustainable development and social progress.
4. Cultivate effective communication, teamwork, and leadership skills in graduates for success in academic, industrial, and research environments, emphasizing on professional ethics.

Mission of the Department to Program Educational Objectives (PEO) Mapping

	PEO 1	PEO 2	PEO 3	PEO 4
Mission Statement 1	3	2	3	3
Mission Statement 2	3	3	2	2
Mission Statement 3	2	3	3	3

Program Specific Outcomes (PSO)

1. Acquire a comprehensive understanding of fundamental and advanced concepts in physics and foster the ability to apply in academic and industry problems.
2. Develop skills in experiment design, data collection and analysis, theoretical modeling, and interpretation of results using modern laboratory techniques and computational tools.
3. Conduct independent and collaborative research projects, address national and societal challenges, and effectively communicate research findings.

Mapping Program Educational Objectives (PEO) to Program Learning Outcomes (PLO)

Program Learning Outcomes (PLO)															
PEOs	POs												PSOs		
	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
PEO 1	3	3	2	2	2	3	1	2	2	2	2	3	3	2	2
PEO 2	3	2	3	3	3	3	2	2	2	2	2	3	2	3	3
PEO 3	2	3	3	3	2	2	3	2	2	3	3	3	2	3	3
PEO 4	2	2	3	2	3	2	2	3	3	3	3	3	3	2	3

Category Wise Credit Distribution			
Course Sub-Category	**Sub-Category Credits**	**Category Credits**	**Learning Hours**
Ability Enhancement Courses (AEC)		2	60
University AEC	0		
School AEC	2		
Value Added Courses (VAC)		4	120
University VAC	4		
School VAC	0		
Skill Enhancement Courses (SEC)		14	420
School SEC	6		
Department SEC	2		
SEC Elective	6		
Foundation / Interdisciplinary courses (FIC)		20	600
School FIC	20		
Department FIC	0		
Core + Core Elective including Specialization (CC)		92	2760
Core	72		
Core Elective (Inc Specialization)	20		
Minor (MC) + Open Elective (OE)	15	15	450
Research / Design / Internship/ Project (RDIP)		17	510
Internship / Design Project / Startup / NGO	5		
Internship / Research / Thesis	12		
	Total	**164**	**4920**

Semester wise Course Credit Distribution Under Various Categories										
Category	**Semester**									
	I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**Total**	**%**
Ability Enhancement Courses - AEC	0	0	2	0	0	0	0	0	2	1
Value Added Courses - VAC	0	0	0	0	0	4	0	0	4	2
Skill Enhancement Courses - SEC	1	3	2	2	3	3	0	0	14	9
Foundation / Interdisciplinary Courses - FIC	12	8	0	0	0	0	0	0	20	12
CC / SE / CE / TE / DE / HSS	8	12	12	16	16	16	12	0	92	56
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	10
Grand Total	**21**	**23**	**19**	**21**	**22**	**26**	**20**	**12**	**164**	**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	SEC	S SEC	ISES 101	Industry Specific Employability Skills-I	0	0	1	1
2	FIC	S FIC	BIO 114	A primer to Biology	3	0	0	3
3	FIC	S FIC	BIO 114L	Practical Biology	0	0	1	1
4	FIC	S FIC	CHE 115	Introduction to Chemistry	3	1	0	4
5	FIC	S FIC	CSC 108	Introduction to Computer Science and Programming Using C	3	0	0	3
6	FIC	S FIC	CSC 108L	Introduction to Computer Science and Programming Using C Lab	0	0	1	1
7	Core	CC	MAT 104	Introduction to Mathematics	4	0	0	4
8	Core	CC	PHY 103	Introduction to Physics	3	0	0	3
9	Core	CC	PHY 103L	Introduction to Physics Lab	0	0	1	1
				Semester Total	**16**	**1**	**4**	**21**

SEMESTER - II								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	SEC	S SEC	RM 100	Introduction to Research	1	0	0	1
2	SEC	S SEC	ISES 102	Industry Specific Employability Skills II	0	0	1	1
3	FIC	S FIC	EGL 100	Introduction to Communicative English	4	0	0	4
4	SEC	S SEC	ENTR 100	Exploratory Learning and Discovery	0	0	1	1
5	FIC	S FIC	ENV 100	Introduction to Environmental Science	4	0	0	4
6	Core	CC	PHY 111	Mathematical Physics	3	1	0	4
7	Core	CC	PHY 112	Classical and Modern Physics	3	0	0	3
8	Core	CC	PHY 113L	Physics Lab - I	0	0	1	1
9	Elective	CE	PHY 116	Waves and Oscillations	3	0	1	4
				Semester Total	**18**	**2**	**3**	**23**

SEMESTER - III								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	AEC	S AEC	AEC 106	Analytical Skills for Sciences	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 102	Digital Literacy	1	0	1	2
5	Core	CC	PHY 201	Introduction to Optics	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	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	D SEC	SEC 107	Mathematical Modelling of Physical Data	2	0	0	2
4	Core	CC	PHY 204	Electrostatics and Electric Current	3	0	1	4
5	Core	CC	PHY 205	Heat and Thermodynamics	3	0	1	4
6	Core	CC	PHY 206	Electrodynamics	3	0	1	4
7	Core	CC	PHY 207	Analog and Digital Electronics	3	0	1	4
8	Elective	OE		Open Elective / Minor	3	0	0	3
				Semester Total	**17**	**0**	**8**	**21**

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 301	Solid-State Physics	3	0	1	4
5	Core	CC	PHY 302	Statistical Physics	3	0	1	4
6	Core	CC	PHY 303	Atomic and Molecular Physics	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	**19**	**2**	**5**	**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 305	Nuclear and Particle Physics	3	1	0	4
5	Elective	CE	CE	Core Elective	3	1	0	4
6	Elective	CE	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**	**3**	**8**	**26**

SEMESTER - VII								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	Elective	CE	CE	Core Elective	3	1	0	4
2	Elective	CE	CE	Core Elective	3	1	0	4
3	Elective	CE	CE	Core Elective	3	1	0	4
4	Elective	OE	OE	Open Elective/Minor	3	0	0	3
5	RDIP	RDIP	PHY 401	Project - I	0	0	5	5
				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 Project	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: Quantum Computation								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	OE	OE	PHY 274	Foundations of Mathematical Physics	3	0	0	3
2	OE	OE	PHY 265	Quantum Mechanics	3	0	0	3
3	OE	OE	PHY 266	Quantum Computation: Background and Formulation	3	0	0	3
4	OE	OE	PHY 267	Quantum Computations and Algorithms	3	0	0	3
5	OE	OE	PHY 268	Quantum Optimization and Computation	3	0	0	3

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

Career Skills Courses								
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

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Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Industry Standard Employability Skills – I

Course Code	ISES 101	**Course Category**	SEC	**L**	**T**	**P**	**C**
				0	0	1	1
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	CDC	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Gain the ability to work in a team and learn leadership skills.
2. Gain the ability to be a leader who can cope up with the challenges, risks, and change management.
3. Gain the ability to understand and be professionals with idealistic practical and moral values.
4. Gain ability to acquire decision making skills in different situations.

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	Recognise the leadership skills for teamwork.	1	70%	60%
Outcome 2	Demonstrate the ability to cope up with changes and challenges.	3	80%	70%
Outcome 3	Manage stress and control emotions.	3	70%	60%
Outcome 4	Apply decision making and problem-solving skills to given scenarios.	3	90%	80%

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			2				
Outcome 2	2					1							2		
Outcome 3					2		2								
Outcome 4	2		1					2		1			2		1
Average	2.0		1.0		2.0	1.0	2.0	1.5		1.0	2.0		2.0		1.0

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	COs Addressed	References Used
Unit No. 1	**Interpersonal skills**	**9**		
	Understanding the relationship between Leadership Networking and Teamwork, Realizing Ones Skills in Leadership	3	1,2	1,2
	Networking & Teamwork and Assessing Interpersonal Skills Situation description of Interpersonal Skill.	3	1,4	1,3
	Teamwork Necessity of Team Work Personally, Socially and Educationally.	3	1,4	1,3
Unit No. 2	**Leadership**	**9**		
	Skills for a good Leader, Assessment of Leadership Skills	3	1,2	1,2
	Change Management, Exploring Challenges	3	1,3	1,2
	Risking Comfort Zone, Managing Change	3	1,3	1,3
Unit No. 3	**Stress management**	**9**		
	Causes of Stress and its impact, how to manage & distress, Understanding the circle of control, Stress Busters.	3	2,3	3,4
	Emotional Intelligence What is Emotional Intelligence, emotional quotient	3	2,3	3,4
	why Emotional Intelligence matters, Emotion Scales. Managing Emotions.	3	2,3	3,4
Unit No. 4	**Conflict resolution**	**9**		
	Conflicts in Human Relations	3	1,4	2,3
	Reasons Case Studies	3	4	2,3
	Approaches to conflict resolution	3	1,4	2,3
Unit No. 5	**Decision making**	**9**		
	Importance and necessity of Decision Making	3	1,4	1,4
	process of Decision Making	3	1,4	1,4
	Practical way of Decision Making, Weighing Positives & Negatives.	3	2,4	1,4
Total Contact Hours		**45**		

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. Covey Sean, Seven Habit of Highly Effective Teens, New York, Fireside Publishers, 1998.
2. Carnegie Dale, How to Win Friends and Influence People, New York: Simon& Schuster, 1998.
3. Thomas A Harris, I am ok, you are ok, New York-Harper and Row, 1972
4. Daniel Coleman, Emotional Intelligence, Bantam Book, 2006.

Other Resources

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

A Primer to Biology

Course Code	BIO 114	**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	Department of Biological Science	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. Understanding the importance of studying biology and the evolution of complex biomolecules and life on Earth provides a foundation for engineers to appreciate the biological principles and systems that underpin many engineering applications.
2. Understanding the structure, function, and significance of biomolecules allows engineers to understand how these fundamental building blocks of life contribute to biological processes.
3. Explaining the structure and function of prokaryotic and eukaryotic cells and understanding the diversity of life.
4. Understanding membrane transport processes, cellular respiration, energy generation, photosynthesis, enzymes, vitamins, and hormones equips engineers with the knowledge of how energy and molecules are processed and utilized within cells, which is essential for designing and optimizing engineered systems.
5. Understanding the structure and organization of DNA and chromosomes and comprehending the central dogma of DNA replication, transcription, and translation provides engineers with a fundamental understanding of genetic information, enabling them to work on genetic engineering, synthetic biology, and other biotechnology applications.
6. Understanding the processes of cell division, understanding mutations, cancer, and genetic diseases gives engineers insights into the genetic basis of diseases and the potential for developing therapeutic interventions or engineering solutions in the field of healthcare and biomedicine.
7. Comprehending the principles and applications of genomics, transcriptomics, proteomics, and metabolomics allows engineers to leverage large-scale biological data to inform design and optimization of engineered biological systems or develop innovative bioinformatics tools and technologies.
8. Applying the knowledge of biological sequences and databases for analyzing biological data empowers engineers to navigate and extract meaningful insights from vast amounts of biological information, enabling them to contribute to areas such as precision medicine, drug discovery, and biotechnology research and development.

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 importance of studying biology and the evolution of complex biomolecules and life on Earth.	2	80%	75%
Outcome 2	Describe the structure, function, and significance of biomolecules, including carbohydrates, lipids, nucleic acids, and proteins.	2	80%	70%
Outcome 3	Explain the structure and functions of prokaryotic and eukaryotic cells, including organelles, and recognize the diversity of life.	2	80%	70%
Outcome 4	Describe membrane transport processes, cellular respiration, energy generation, photosynthesis, enzymes, vitamins, and hormones.	2	75%	70%
Outcome 5	Describe the structure and organization of DNA and chromosomes, and comprehend the central dogma of DNA replication, transcription, and translation.	2	75%	70%
Outcome 6	Explain the processes of cell division (mitosis and meiosis) and understand the concepts of mutations, cancer, and genetic diseases.	2	75%	70%
Outcome 7	Explain the principles and applications of genomics, transcriptomics, proteomics, and metabolomics.	2	80%	75%
Outcome 8	Explain the concept of biological sequences and databases, including the use of tools such as BLAST and protein/Gene ID conversion, for analysing biological data.	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	1		5				2			3	2	6	3	1	2
Outcome 2	2	3					2	3		3	2		3	2	2
Outcome 3	2	3						3	3		2		3	2	2
Outcome 4	2	3		4			3	2		3	2	2	3	2	2
Outcome 5	2	3						3	3		2	3	3	2	2
Outcome 6	2	3	5				4	3	4	2	2		3	1	2
Outcome 7	2	3			5		3	3	3	3	2	3	3	2	2
Outcome 8	2	3				3			3	3	2	2	3	2	2
Average	**2**	**3**	**1**	**1**	**1**	**1**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**2**	**2**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Life: Origin, composition and chemistry**	**5**		
	Origin of complex Biomolecules and primitive cells	1	1, 2	1, 2, 3
	Chemical basis of life	1	1, 2	1, 2, 3
	Importance of carbon - synthesis by polymerization; importance of self assembly;	1	1, 2	1, 2, 3
	Importance of Water- synthesis by polymerization; importance of self assembly;	1	1, 2, 5	1, 2, 3
	Selectively permeable membranes	1	1, 2	1, 2, 3
Unit 2	**Cell Biology**	**12**		
	Prokaryotes and eukaryotes (cell structures and organelles);	2	1, 2, 3	1, 2, 3
	Virus- lysogenic and lytic cycles;	3	1, 2, 3	1, 2, 3
	Bacteria- typical bacterial cells, bacterial gene transfer- conjugation, transformation, and transduction	3	1, 2, 3	1, 2, 3
	Antibiotic resistance- an emerging threat; Microbiome	3	1, 2, 3	1, 2, 3
	Cell cycle- mitosis and meiosis.	1	1,2	1, 2, 3
Unit 3	**Energy harvesting reactions by life forms**	**10**		
	The importance of energy in biological systems; Gibbs free energy (Δ G);	2	1,3	1, 2, 3
	Biological reactions: Enzymes and their equilibrium constants (Keq);	2	1, 2	1, 2, 3
	Energy harvesting: Chemotrophic, Phototrophic;	2	1,2	1, 2, 3
	Metabolism: Glycolysis, anaerobic and aerobic cellular respiration.	2	1,2	1, 2, 3
	Fate of food in cellular energy cycle.	2	1,2	1, 2, 3

Unit No. 4	**Molecular Biology**	**9**		
	Structure of DNA and organization of chromosomes;	2	1-5	1, 2, 3
	Central dogma- replication, transcription, and translation in prokaryotes.	3	1-5	1, 2, 3
	Mutations, cancer and hereditary diseases.	2	1-5	1, 2, 3
	Introduction to genetic manipulation- concepts of restriction digestion, cloning	2	1-5	1, 2, 3
Unit No. 5	**Bioinformatics**	**9**		
	Biological sequences and evolution of sequencing technologies.	3	1,5	4
	Utilization of sequence information in personalized medicine and disease detection.	3	1,5	4
	Structural Biology: Biomolecular structures and their databases.	3	1,5	4
Total Contact Hours		**45**		

Learning Assessment

Bloom's Level of Cognitive Task		**Continuous Learning Assessments 50%**				**End Semester Exam 50%**
		CLA-1 10%	**Mid-1 15%**	**CLA-2 10%**	**CLA-3 15%**	
Level 1	Remember	80%	90%	90%	50%	80%
	Understand					
Level 2	Apply	20%	10%	10%	50%	20%
	Analyse					
Level 3	Evaluate					
	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
2. Life: The Science of Biology, 11th Edition (2017). David Sadava, David M. Hillis, H. Craig Heller, Sally D. Hacker. SINAUER ASSOCIATES MACMILLAN.
3. The Physiological Society (https://www.youtube.com/user/PhysocTV)

Other Resources

Course Designers

1. All Faculty Members, Department of Biological Sciences, SRM University – AP.

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Practical Biology Lab

Course Code	BIO 114L	**Course Category**	FIC	**L**	**T**	**P**	**C**
				0	0	1	1
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Biological Sciences	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Understand and implement lab safety rules and proficiently handle micropipettes and pH meters for secure laboratory practices.
2. Develop skills in buffer preparation and gain familiarity with basic laboratory instruments, including microscopes, autoclaves, spectrophotometers, centrifuges, incubators, and laminar air-flow cabinets.
3. Master cell counting using a hemacytometer, enabling precise quantification of cell populations for diverse biological applications.
4. Acquire proficiency in growth media and plate preparation through demonstration and develop skills in culturing microorganisms from various sources, showcasing competence in microbiological 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	Demonstrate a thorough understanding of lab safety protocols and proficiently handle essential laboratory equipment, ensuring a secure working environment.	4	80%	75%
Outcome 2	Develop precision in using micropipettes and pH meters, successfully prepare buffers and growth media, and acquire skills in observing mitosis stages in onion root tips and thin plant specimens under a microscope.	3	70%	65%
Outcome 3	Gain competence in the operation and safety procedures of fundamental laboratory instruments, including microscopes, autoclaves, spectrophotometers, centrifuges, incubators, and laminar air-flow cabinets.	3	70%	65%
Outcome 4	Acquire practical expertise in culturing microorganisms from various sources (air, soil, coins, and skin), observe the preparation of growth media and plates through a demonstration, and master cell counting using a hemacytometer.	3	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	3	2	3	3	3	2	1	3	3	3			3	1	2
Outcome 2	3	2	3	3	3	2	1	3	3				3	2	2
Outcome 3	3	3	3	3	3	2	1	3	3	3			3	3	2
Outcome 4	3	2	3	3	3	2	1	3	3	3			3	3	2
Average	**3.0**	**2.3**	**3.0**	**3.0**	**3.0**	**2.0**	**1.0**	**3.0**	**3.0**	**3.0**			**3.0**	**2.3**	**2.0**

Course Unitization Plan

Exp No.	Description of Experiment	Required Contact Hours	CLOs Addressed	References Used
1	Lab safety introduction Handling micropipettes and pH meter	5	1	1
2	Preparation of buffers; Introduction to basic instrumentation: microscope, autoclave, spectrophotometer, centrifuge, incubators, and laminar air-flow cabinets	5	2	1
3	Observing stages of mitosis in onion root tip. Observing thin specimens of plant samples under the microscope	5	3,4	1
4	Preparation of growth media and plates (demonstration)	5		
5	Culturing microorganisms from air, soil, coins, and skin	5	3,4	1
6	Cell counting using hemocytometer	5	3,4	1
Total Contact Hours		**30**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)			End Semester Exam (50%)
		Experiments (20%)	Record / Observation Note (10%)	Viva + Model (20%)	
Level 1	Remember	50%		50%	50%
	Understand				
Level 2	Apply	50%	100%	50%	50%
	Analyse				
Level 3	Evaluate				
	Create				
Total		**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Practical Biochemistry, Leininger

Other Resources

1. https://amrita.edu/course/biochemistry-practical/

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Introduction to Chemistry

Course Code	CHE 115	**Course Category**	FIC	**L**	**T**	**P**	**C**
				3	1	0	4
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Chemistry	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To distinguish the types of bonding and predict the shape of the molecules using the valence shell electron pair (VSEPR) model and molecular orbital (MO) theory.
2. To classify the states of matter and discuss their behavior and properties.
3. To explain the redox reactions and demonstrate their applications in the electrochemical cells
4. To explain the classification, nomenclature, and electronic properties of organic compounds.
5. To describe the different types of organic reactions and their purification techniques.
6. To discuss the structures and the properties of carbohydrates, amino acids, proteins and vitamins, and nucleic acids and list the toxicity of the metals

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	Distinguish the types of bonding and predict the shape of the molecules using the valence shell electron pair (VSEPR) model and molecular orbital (MO) theory.	2	80%	85%
Outcome 2	Classify the states of matter and their behavior and properties	2	80%	80%
Outcome 3	Explain the redox reactions and demonstrate their application in the electrochemical cells.	3	80%	75%
Outcome 4	Classify electronic properties of organic compounds and reactions.	2	80%	70%
Outcome 5	Discuss the structures and the properties of carbohydrates, amino acids, proteins and vitamins, nucleic acids and can list the toxicity of the metals.	2	80%	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	2	3	2	2		2	2	1	3	2	2	2	2	2	2
Outcome 2	2	2	2	1		2	2	1	1	3	2	2	2	2	2
Outcome 3	2	2	1	1		2	3	3	3	3	2	1	2	2	1
Outcome 4	2	3	2	2		2	2	1	3	2	2	1	2	2	3
Outcome 5	2	2	1	1		2	3	3	2	2	2	1	2	2	2
Average	2.0	2.4	1.6	1.4		2.0	2.4	1.8	2.4	2.4	2.0	1.4	2.0	2.0	2.0

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	**Chemical Bonding and Molecular Structure**	**8**		
	Importance and scope of chemistry (Central Science)	1	1	2
	Valence electrons, ionic bond, covalent bond, Hydrogen bond	1	1	2
	Valence bond theory	1	1	2
	The geometry of covalent molecules	1	1	
	VSEPR theory	1	1	2
	The concept of hybridization involving *s, p,* and *d* orbitals	1	1	2
	Shapes of some simple molecules	1	1	2
	Molecular orbital theory of homonuclear diatomic molecules (qualitative idea only)	1	1	2
	Tutorial 1	3	1	2
Unit No. 2	**States of Matter**	**12**		
	Three states of matter, intermolecular interactions Gases: The behavior of gases, changes in the volume of a gas with pressure; Boyle's law	1	2	1
	Change in volume of a gas with temperature; Charles's law	1	2	1
	Gay Lussac's law, Avogadro's law, Ideal gas law	1	2	1
	Empirical derivation of gas equation, Kinetic molecular theory	1	2	1
	Deviation from ideal gas law.	1	2	1
	Liquids – Liquid State – Vapour pressure, viscosity, and surface tension	1	2	1
	Introduction to solutions, different types of solutions	1	2	1
	Raoult's Law (change of state),	1	2	1
	Constant boiling mixtures (azeotropic mixtures (distillation)	1	2	1
	Nature and different types of solids including covalent, non-covalent ionic, and metallic solids	1	2	1
	Solids and their bonding, Band theory	1	2	1
	Application of crystalline materials in electronic devices.	1	2	1
	Tutorial 2	3	1	1
Unit No. 3	**Redox Reactions**	**8**		
	Concept of oxidation and reduction, redox reactions	1	3	2
	redox reactions	1	3	2
	Oxidation number, balancing redox reactions in terms of loss and gain of electron and change in oxidation numbers	1	3	2
	Applications of redox reactions	1	3	2
	Nomenclature applicable to electrochemical cells, viz., electromotive force, electrochemical series.	2	3	2
	Evolution of electrochemical cells: from voltaic cells to Li-ion battery	2	3	2
	Tutorial 3	3	3	2
Unit No. 4	**Basic Principles of Organic Chemistry**	**12**		
	General introduction, classification	1	4	3,4
	IUPAC nomenclature of organic compounds.	2	4	3,4
	Electronic displacements in a covalent bond	1	4	3,4
	Inductive effect, electrometric effect, resonance, and hyperconjugation	2	4	3,4
	Homolytic and heterolytic fission of a covalent bond	1	4	3,4
	Free radicals, carbocations, carbanions	1	4	3,4
	Electrophiles and nucleophiles	1	4	3,4
	Types of organic reactions	1	4	3,4
	Purification methods: Qualitative and quantitative analysis	2	4	3,4
	Tutorial 4	3	4	3,4
Unit No. 5	**Chemistry of Life**	**5**		
	Carbohydrates, Amino acids, peptide bonds	1	5	3,4
	Secondary and tertiary structures of proteins, enzymes, vitamins, Nucleic acids, bioinorganic chemistry	2	5	3,4
	Toxicity of heavy metals (Cu, Fe, As, Pb, Hg, Co, Cr, Cd, etc.),	2	5	3,4
	Tutorial 5	3	5	3,4
	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. Peter Atkins, & Paula, J. de. Elements of Physical Chemistry 7th Ed., Oxford University Press (2014).
2. Concise Inorganic Chemistry: J.D. Lee (1999) 5th edition, Blackwell Science.
3. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press.

Other Resources

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Introduction to Computer Science and Programming Using C

Course Code	CSC 108	**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	CSE	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Gain basic knowledge in C programming language.
2. Acquire knowledge on Decision making and functions in C.
3. Learn arrays, strings and pointers concept in C.
4. Understand the basics concepts of Structures, Union and File handling techniques
5. Using C Programming.

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 C structures, enumerators, keywords, header files and operators	2	75 %	70%
Outcome 2	Illustrate Decision-Making statements and Functions.	3	70 %	65%
Outcome 3	Interpret arrays, strings, and pointers programming in C	3	70 %	65%
Outcome 4	Apply Structures, unions, File handling operations on different scenarios	3	70 %	65%
Outcome 5	Solve given projects based on C concepts	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	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
Average	3.0	3.0	2.0	1.6								2.0	2.8	2.0	2.8

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	**INTRODUCTION TO COMPUTER SCIENCE**	**9**	1	1
	Fundamentals of Computing, Historical perspective, Early computers	2	1	1,2
	Computing machine. Basic organization of a computer: ALU, input-output units, memory, program counter - variables and addresses - instructions: store, arithmetic, input and output	2	1	1,2
	Problem solving: Algorithm / Pseudo code, flowchart, program development steps	2	1	1,2
	Computer languages: Machine, symbolic and high-level langua Level languages	1	1	1,2
	Creating and Running Programs: Writing, editing (any editor), compiling (gcc)	1	1	1,2
	linking, and executing in Linux environment	1	1	1,2
Unit No. 2	**C PROGRAMMING BASICS**	**9**		
	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 conversion	1	1	1,2
	Conditional Expressions Precedence and order of evaluation, Sample Program	1	1	1,2
	SELECTION & DECISION MAKING: if-else, null else, nested if, example multi-way selection: switch, else-if, examples.	2	1	1,2
	ITERATION: Loops - while, do-while and for, break, continue,	1	1	1,2
	initialization and updating, event and counter controlled loops and examples.	2	1,2	1,2
Unit No. 3	**FUNCTIONS AND ARRAYS**	**10**		
	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
Unit No. 4	**POINTERS**	**10**		
	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
Unit No. 5	**ENUMERATED, STRUCTURE AND UNION TYPES**	**7**		
	Structures - Declaration, definition, and initialization of structures, accessing structures	1	5	2, 3, 4
	nested structures, arrays of structures, structures and functions, pointers to structures,	1	5	2, 3, 4
	self-referential structures. Unions, typedef, bit-fields, program applications	2	5	2, 3, 4
	Bit-wise operators: logical, shift, rotation, masks.	1	5	2, 3, 4
	FILE HANDLING: Concept of a file, text files and binary files, formatted I/O, file I/O operations and example programs.	2	5	2, 3, 4
	Total Contact Hours	**45**		

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. 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

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Introduction to Computer Science and Programming using C Lab

Course Code	CSC 108L	**Course Category**	FIC		**L**	**T**	**P**	**C**
					0	0	1	1
Pre-Requisite Course(s)		**Co-Requisite Course(s)**	CSC 108	**Progressive Course(s)**				
Course Offering Department	CSE	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. Learn and understand C programming basics and paradigm.
2. Acquire knowledge on decision making and functions in C.
3. Acquire knowledge on decision making, loop concept, control statements, arrays, string and functions using C.
4. Learn basics of Structures, Union, and File handling concepts in C.

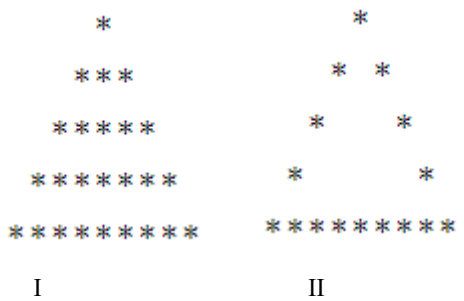
Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Describe fundamentals in C, enumerators, datatypes, vakeywords, header files and operators	2	75 %	70%
Outcome 2	Illustrate Decision-Making statements and Functions.	3	70 %	65%
Outcome 3	Interpret arrays, strings, and pointers programming in C	3	70 %	65%
Outcome 4	Apply Structures, unions, File handling operations on different scenarios	3	70 %	65%
Outcome 5	Solve given projects based on C concepts	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	3	3	3	2				2				3	2	
Outcome 2	2	2	3	3	2				2				2	2	
Outcome 3	2	3	3	2	2				2				2	2	
Outcome 4	3	3	3	3	2				3				2	3	
Outcome 5	2	3	3	3	3				3				2	2	
Average	**2.2**	**2.8**	**3.0**	**2.8**	**2.2**				**2.4**				**2.2**	**2.2**	

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	**INTRODUCTION TO COMPUTER SCIENCE**	**4**		
	Lab Experiment 1: GCC Compiler using Linux, various Linux comman 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. 2	**C PROGRAMMING BASICS**	**6**		
	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  I II	2	1,2	1,2
Unit No. 3	**FUNCTIONS AND ARRAYS**	**9**		
	Lab Experiment 6: **a)** (nCr) and (nPr) of the given numbers $1+x+x^2\backslash 2+x^3\backslash 3!+x^4\backslash 4!+\ldots\ldots\ldots X^n\backslash n!$	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 b. Sorting array elements.	2	2,3	1,2
	Lab Experiment 8: . Transpose of a matrix. b.Addition and multiplication of 2 matrices.	2	2,3	1,2
	Lab Experiment 9: . Function to find both the largest and smallest number of an array of integers. . Liner search. . 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 . If Def . Undef . Pragma	1	2,3	1,2
Unit No. 4	**POINTERS**	**6**		
	Lab Experiment 10: . Illustrate call by value and call by reference. . Reverse a string using pointers Compare two arrays using pointers	2	3, 4	1,2,3
	Lab Experiment 11: . Array of Int and Char Pointers. Array with Malloc(), calloc() and realloc().	2	3, 4	1,2,3

	Lab Experiment 12: . To find the factorial of a given integer. . To find the GCD (greatest common divisor) of two given integers. . Towers of Hanoi	2	3, 4	1,2,3
Unit No. 5	**ENUMERATED, STRUCTURE AND UNION TYPES**	**4**		
	Lab Experiment 13: . Reading a complex number . Writing a complex number. . Addition of two complex numbers Multiplication of two complex numbers	2	5	2, 3, 4
	Lab Experiment 14: . File copy . Word, line and character count in a file.	2	5	2, 3, 4
Total Contact Hours		**29**		

Learning Assessment

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (50%)**		**End Semester Exam (50%)**	
		Lab Record (20%)	**Projects Presentations (30%)**	**Lab Record (20%)**	**Projects Presentations (30%)**
		Practical	Practical	Practical	Practical
Level 1	Remember	70%	60%	30%	40%
	Understand				
Level 2	Apply	30%	40%	70%	60%
	Analyse				
Level 3	Evaluate				
	Create				
Total		**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

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Introduction to Mathematics

Course Code	MAT 104	**Course Category**	Core	**L**	**T**	**P**	**C**
				4	0	0	4
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 firm up the language of mathematics, primarily the notion of sets, functions, sequences.
2. To understand polynomials, solving simultaneous linear equations, exponential and logarithmic functions.
3. To learn to count the outcomes of permutations and combinations, appreciate the importance of mathematical modelling and data analysis.
4. To understand spatial representation, the connection between geometry and algebra, notions such as symmetry.
5. To learn the basics of calculus.

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	Write mathematical arguments logically and use the symbol system that is in use universally	3	90%	75%
Outcome 2	Solve problems involving a system of simultaneous linear equations, quadratic polynomials, and other simple algebraic equations algebraically and graphically	3	75%	65%
Outcome 3	Compute the permutations and combinations, sort and arrange data and do elementary data analysis	3	75%	65%
Outcome 4	Differentiate and integrate simple functions and apply their knowledge	3	75%	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	3	3	2	1	2	-	-	-	-	-	-	2	2	2
Outcome 2	3	3	3	3	1	2	-	-	-	-	-	-	3	3	3
Outcome 3	3	3	3	3	1	2	-	-	-	-	-	-	3	3	3
Outcome 4	3	3	3	3	1	2	-	-	-	-	-	-	3	3	3
Average	**3**	**3**	**3**	**3**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**3**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Numbers Sets and Number Systems**	**14**		
	A brief history of numbers and numeration systems, number base, place value notation, zero as a number	2	1	1,2
	Base 10 and algorithmizablility of the four basic operations, counting and counting numbers, measurement, ratio-proportions and fractions, commensurability, and irrationality	2	1	1,2
	The language of sets- notation, subsets, union, intersection, complementation, powerset of a set, finite and infinite sets	2	1	1,2
	Functions- one-one, onto, one-to-one correspondence, inverse of a function, operations on functions	2	1	1,2
	Natural numbers, integers, rational, real, and complex number systems, representation on the number line, complex plane	2	1	1,2
	Number patterns, Arithmetic, and geometric progressions	2	1	1,2
	Sequences including Fibonacci and series, summability	2	1	1,2
Unit 2	**Algebraic Thinking**	**12**		
	Representing unknowns and variables, arithmetic on symbols, turning sentences into algebraic expressions	2	2	1,2
	Polynomial expressions, degree of a polynomial, polynomial equations, factorizing polynomials,	2	2	1,2,
	Algebraic equations, identities, inequalities, graphical representation of polynomials, roots of a polynomial, solving quadratic equations in one variable	3	2	1,2
	solving linear equations in 2 or 3 variables,	2	2	1,2,
	Factor and remainder theorem, Some fascinating examples from history. Polynomial, exponential, logarithmic, and rational functions.	3	2	1,2
Unit3	**Spatial Understanding**	**12**		
	A brief look at Euclidean and other geometries, Descartes and the Cartesian coordinate system,	2	2	1,2
	coordinate geometry and algebraic representation of some familiar geometrical objects;	2	2	1,2
	solving polynomial equations- a geometric perspective,	3	2	1,2
	Trigonometry, and trigonometric functions	3	2	1,2
	Symmetries of polygons	2	2	1,2
Unit4	**Mathematical Modelling and Data Analysis**	**14**		
	Permutations and Combinations	4	3	1,2
	Elementary graph theory and some famous problems,	2	3	1,2
	Data, Sorting and representing data as tables and pictograms,	2	3	1,2
	Measures of central tendency: Mean, median, mode, Variations and standard deviation,	4	3	1,2
	Mathematical Models and Constructing mathematical models	2	3	1,2
Unit5	**Calculus: An Introduction**	**8**		
	Derivative of polynomial, exponential and trigonometric functions	2	4	1,2
	Applications of derivative, ,	2	4	1,2
	Integration of a function	2	4	1,2
	Applications of integration	2	4	1,2
Total Contact Hours		**60**		

Learning Assessment

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

Recommended Resources

1. An Introduction to Mathematics by A. N. Whitehead, Williams and Norgate Henry Holt and Co., New York.
2. Introduction to The Foundations of Mathematics, By Raymond L. Wilder, Dover
3. Publications, Inc. Mineola, New York.

Other Resources

Course Designers

1. Sazzad Ali Biswasand Jayasree Subramanian

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Introduction to Physics

Course Code	PHY 103	**Course Category**	CC	**L**	**T**	**P**	**C**
				3	0	0	3
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. Knowledge on great scientific discoveries in modern physics.
2. To understand fundamental concepts of classical mechanics with practical pplications.
3. To understand fundamental concepts of electricity and magnetism with practical applications.
4. To understand fundamental concepts crystal physics with X-ray/electron diffraction methods.
5. To understand types of solids based on energy band diagram

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	Great discoveries in Physics 19 Century	2	70%	65%
Outcome 2	Explain and apply conservation of linear momentum and conservation of mechanical energy	2	70%	65%
Outcome 3	Understand and explain concepts magnetic ekectric field and electromagnetic field	3	70%	65%
Outcome 4	Explain concept of wave particle duality, Quantum Mechanics	3	70%	65%
Outcome 5	Explain basic concept of lattice and X-ray diffraction of crystalline materials	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	2	3	3	2	1	2	-	-	-	-	-	-	2	2	2
Outcome 2	3	3	3	3	1	2	-	-	-	-	-	-	3	3	3
Outcome 3	3	3	3	3	1	2	-	-	-	-	-	-	3	3	3
Outcome 4	3	3	3	3	1	2	-	-	-	-	-	-	3	3	3
Outcome 5	3	3	3	3	1	2	-	-	-	-	-	-	3	3	3
Average	2.8	3.0	3.0	2.8	1.0	2.0							2.8	2.8	2.8

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact hours	CLOs Addressed	Reference Used
Unit No. 1	**Great Discoveries in Physics**	**9**		
	Bremsstrahlung: Braking radiation	1	1	1,2
	Radioactivity	1	1	1,2
	Various models of atoms	1	1	1,2
	Light: Particle or Wave?	1	1	
	Radio waves and long-distance communication	1	1	1,2
	Raman effect and applications	1	1	1,2
	Concept of Ether: Michelson-Morley experiment	1	1	1,2
	Gravitational Waves	1	1	1,2
	Zero resistance and superconductivity	1	1	1,2
Unit No. 2	**Mechanics**	**9**		
	Scalars and vectors, their various products	1	1,2	1,2
	Newton's Laws of motion and kinematics	1	1,2	1,2
	Free body force diagrams and applications on Inclined plane motion	1	1,2	1,2
	Simple Pulley	1	1,2	1,2
	Problem solving, quiz and Group activities on kinematics	1	1,2	1,2
	Impulse and Average force	1	1,2	1,2
	Conservation of linear momentum	1	1,2	1,2
	Work Energy conservation, and application in bullet's motion	1	1,2	1,2
	Conservation of mechanical energy: Pendulum systems	1	1,2	1,2
Unit No. 3	**Electricity and magnetism**	**9**		
	Atoms, types of charge carriers and quantization	1	1,2,3	1,2
	Force between charges, electric field and electric lines of force	1	1,2,3	1,2
	Concept of electric potential and potential difference	1	1,2,3	1,2
	Current through a conductor and Ohm's law	1	1,2,3	1,2
	Force between two current carrying conductors	1	1,2,3	1,2
	Magnetic field and magnetic lines of forces and types of magnets	1	1,2,3	1,2
	Force on a charge due to electric and magnetic field	1	1,2,3	1,2
	Cyclotron motion	1	1,2,3	1,2
	Accelerated charged particles and electromagnetic wave	1	1,2,3	1,2

	(concept)			
Unit No. 4	**Modern Physics**	**9**		
	Longitudinal and transverse waves, travelling wave	1	4	1, 2
	Electromagnetic waves and EM spectrum	1	4	1, 2
	Blackbody radiation, classical interpretation and Planck's hypothesis	1	4	1, 2
	Photoelectric effect and particle nature of wave	1	4	1, 2
	Wave properties of particles and de-Broglie hypothesis	1	4	1, 2
	Concept of Wave function	1	2,4	1, 2
	Probability, physical significance of wavefunction	1	1,2,4	1, 2
	Wavefunction, probability and energy of particle in a box with infinite potential (concept only)	1	1,2,4	1, 2
	Heisenberg's uncertainty principle	1	1,2,4	1, 2
Unit No. 5	**Crystal Physics**	**9**		
	Crystalline, amorphous and glassy phases	1	3,5	2, 3
	Concept of lattice and basis	1	3,5	2, 3
	Primitive unit cell, Bravais lattice, Symmetry elements and operations: rotation, reflection, inversion	1	3,5	2, 3
	in simple, face centered and body centered cubic lattices	1	3,5	2, 3
	Lattice planes and Miller indices	1	3,5	2, 3
	Bragg's law of X-Ray diffraction in crystal	1	3,5	2, 3
	Group activities on X-Ray diffraction methods	1	3,5	2, 3
	Energy band diagrams in metals, insulators and semiconductors	1	3,5	2, 3
	X-ray and Electron diffraction, their applications in solid state physics.	1	3,5	2, 3
Total Contact hours		**45**		

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. Physics for Scientist and Engineers - Raymond A. Serway, John W. Jewett, XIX Edition (2017), Publisher - Cengage India Private Limited
2. Concept of Modern Physics - Arthur Beiser, Shobhit Mahajan, S Rai, 2017 Edition, Publisher - Tata McGraw Hill
3. Introduction to Solid State Physics, 8th Edition Charles Kittel 8th edition Wiley India Pvt Ltd
4. K.G. Mazumdar and B. Ghosh, "Advanced Practical Physics" Sreedhar Publishers, Revised edition Jan 2004
5. R.K. Shukla and Anchal Srivastava, "Practical Physics" New Age international (P) limited Publishers, 2006 [ISBN(13) – 978-81-224-2482-9]

Other Resources

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Introduction to Physics Lab

Course Code	PHY 103L	**Course Category**	CC	**L**	**T**	**P**	**C**
				0	0	1	1
Pre-Requisite Course(s)		**Co-Requisite Course(s)**	PHY 103	**Progressive Course(s)**			
Course Offering Department	Physics	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Operate physics equipment and measurement tools.
2. Determine physical constants and fundamental materials properties in mechanics, electromagnetism, and optics.
3. To collect experimental data, analyse and graph plot.

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 basic equipment operation and analysis	2	70%	65%
Outcome 2	Compute time period, acceleration due to gravity, viscosity and spring constant	2	70%	65%
Outcome 3	Explain working principle of compound pendulum, spring and thermodynamic laws	3	70%	65%
Outcome 4	Verify basic laws of electromagnetism and optics using experimental results	3	70%	65%
Outcome 5	Plot graphs and analyse the experimental results	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	2	3	3	2	1	2	-	-	-	-	-	-	2	2	2
Outcome 2	3	3	3	3	1	2	-	-	-	-	-	-	3	3	3
Outcome 3	3	3	3	3	1	2	-	-	-	-	-	-	3	3	3
Outcome 4	3	3	3	3	1	2	-	-	-	-	-	-	3	3	3
Outcome 5	3	3	3	3	1	2	-	-	-	-	-	-	3	3	3
Average	**3**	**3**	**3**	**3**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**3**

Course Unitization Plan

Exp. No.	Description of Experiment	Required Contact Hours	CLOs Addressed	References Used
1	Compound Pendulum: Acceleration due to gravity and radius of gyration of the given pendulum	4	2	4, 5
2	Hooke's law and determination of spring constant for a given spring	2	2	4, 5
3	Biot-savart law: Dependence of magnetic field on the current and magnetic field variation along the axis of a current carrying circular loop	4	2	4, 5
4	Faraday law & Induced E.M.F: Measurement of the induced voltage and calculation of the magnetic flux induced by a falling magnet	2		
5	Verification of Stefan's Law of blackbody radiation	2	3	4, 5
6	Measurement of dielectric constant of air and a given object using parallel plate capacitor	4	3	4, 5
7	Photoelectric effect and Planck's Constant determination	4	4	4, 5
8	Spectral lines from Hydrogen discharge lamp: Balmer Series and Rydberg constant	4	4	4, 5
9	Powder X-Ray diffraction patterns of NaCl and KCl	4	5	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%)		Mid-1 (20%)		CLA-2 (15%)		CLA-3 (15%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember		40%		40%		60%				50%
	Understand										
Level 2	Apply		60%		60%		40%				50%
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100%**		**100%**		**100%**				**100%**	

Recommended Resources

1. Laboratory manuals, SRM University – AP
2. R.K. Shukla and Anchal Srivastava, "Practical Physics" New Age international (P) limited Publishers, 2006 [ISBN(13) – 978-81-224-2482-9]
3. Physics for Scientist and Engineers - Raymond A. Serway, John W. Jewett, XIX Edition (2017), Publisher - Cengage India Private Limited
4. Concept of Modern Physics - Arthur Beiser, Shobhit Mahajan, S Rai, 2017 Edition, Publisher - Tata McGraw Hill

Other Resources

Course Designers

1. Dr Sabyasachi Mukhopadhyay, Assistant Professor, Dept. of Physics, SRM University - AP
2. Dr. Pranab Mandal, Assistant Professor, Dept. of Physics, SRM University - AP
3. Prof. Ranjit Thapa, Professor. Dept. of Physics. SRM University - AP
4. Prof. M. S. Ramachandra Rao, Professor, Department of Physics, Indian Institute of Technology, Madras
5. Prof. D. Narayana Rao, Raja Ramanna Fellow, University of Hyderabad

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Introduction to Research

Course Code	RM 100	Course Category	SEC	L	T	P	C
				1	0	0	1
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Chemistry	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. To facilitate the students in understanding the basics of research
2. To educate the young researchers on methods of research
3. To prepare the students to apply research in scientific 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	Illustrate the importance of research	2	85%	80%
Outcome 2	Demonstrate research acumen in the research process	3	80%	75%
Outcome 3	Apply the research method in given scenarios	5	80%	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	2	3	2	1		1	2	3	3	2		3	1	2
Outcome 2	2	3	2	1	3		3	3	2	3	3		2	3	3
Outcome 3	1	3	1	3	2		2	1	2	2	1		1	2	1
Average	**2.0**	**2.7**	**2.0**	**2.0**	**2.0**		**2.0**	**2.0**	**2.3**	**2.7**	**2.0**		**2.0**	**2.0**	**2.0**

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	**Introduction to Scientific Research**	**7**	**1**	**1,2**
	Importance of Research	2		
	Objectives of Research	2		
	Types of Research	3		
Unit No. 2	**Introduction to Research Articles**	**8**	**2**	**1,3**
	Literature survey	2		
	Tools to collect research articles	2		
	Identifying research problem	1		
	Understanding research articles	1		
	Different components in a research article	1		
	Review articles and book chapters, report writing	1		
Unit No. 3	**Scientific Conduct**	**8**	3	**1,2,3**
	Ethics with respect to science and research	2		
	Intellectual honesty and research integrity	2		
	Scientific misconducts: falsification, fabrication, and plagiarism	2		
	Redundant publications: duplicate and overlapping publications	2		
Unit No. 4	**Research Management and Collaboration**	**7**	3	**1**
	Google scholar, ResearchGate	3		
	Citations, h-index, i10 index	2		
	Bibliography, reference manager (Mendeley)	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	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. Bordens K.S. and Abbott, B.b.: Research Design and Methods, Mc Graw Hill, 2008
2. Kothari C.K., Research Methodology- Methods and Techniques (New Age International, New Delhi), 2004
3. Catherine Dawson, Introduction to Research Methods, 2005

Other Resources

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Industry Standard Employability Skills -II

Course Code	ISES 102	**Course Category**	SEC	**L**	**T**	**P**	**C**
				0	0	1	1
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	CDC	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Develop interpersonal skills to be a good team player.
2. Develop socialization skills, positive attitude, and behavioural skills
3. Eliminate the barriers of communication and make conscious efforts to improve skill sets.
4. Recognise practice and acquire the skills necessary to deliver effective presentation with clarity and impact.

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	Recognise the intrinsic motivating factors.	1	70%	60%
Outcome 2	Demonstrate the ability to conceptualize an original idea.	3	80%	70%
Outcome 3	Solve the given problems using lateral thinking techniques	3	70%	60%
Outcome 4	Apply interpersonal skills to be a team player	3	90%	80%

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			2		2		1			
Outcome 2		2			3			3	3						
Outcome 3		3							2			2			
Outcome 4								2	3			2			
Average		2.5			2			2.3	2.7	2		1.7			

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	COs Addressed	References Used
Unit No. 1	**Motivation**	**9**		
	Soldiers' walk (Activity on factors of motivation)	3	1,4	1,4
	The Japanese fan (An activity on factors 1of motivation)	3	1,4	1,4
	Steps to ward off demotivation.	3	1,4	1,4
Unit No. 2	**Creativity and innovation**	**9**		
	Short film: (Students are encouraged to make a ten-minute documentary on various topics to enhance the power of aesthetics and precision)	3	1,2	1,4
	Creative short film (This activity is aimed at creating an interest on research and think out of the box)	3	1,2	1,4
Unit No. 3	**Critical and lateral thinking**	3		
	Fill me up, stimulating lateral thinking	**9**	1,2	2,4
	The curious case of Mary and Kevin (Activity triggering the different types of thinking)	3	2,3	2,4
	The creative college	3	2	2,4
Unit No. 4	**Team dynamics**	3		
	Story boarding, Frenzy, come to my island.	**9**	1,2,3	2,3
	Striking cars	3	1,2	2,3
	Defend the egg, tallest tower (Activities on the different stages of team building, team communication, coordination, and collaboration.	3	1,2,3	2,3
Unit No. 5	**Mini project**	3		
	Concept 1: Mini project presentation	**9**	1,2,3,4	1,4
	Concept 2: Mini project presentation	3	1,2,3,4	1,4
	Concept 3: Mini project presentation	3	1,2,3,4	1,4
Total Contact Hours		**45**		

Learning Assessment

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

Recommended Resources

1. Personality development and soft skills – Braun K. Mitra
2. Key to success in workplace and life – Meenakshi Roman, Shalini Upadhyay.
3. Mastering soft skills – Julian Vyner
4. The Accidental Creative – How to be brilliant at a moment's notice – Todd

Other Resources

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Introduction to Communicative English

Course Code	EGL 100	**Course Category**	FIC	**L**	**T**	**P**	**C**
				4	0	0	4
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	English	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To Introduce the Principles and Practices of Effective Communication Skills in various contexts.
2. To understand the purpose and differentiate various types of audience.
3. To encourage self-evaluation while collaborating with peers during learning.
4. To prepare the students to produce Language in various contexts be it Oral or Written form.

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	Employ all four skills (listening/speaking/ reading/writing) to express themselves using production skills (Speak and Write)	3	90%	90%
Outcome 2	Illustrate views using Power Point and Word.	3	70%	80%
Outcome 3	Express with proper grammar.	2	60%	50%
Outcome 4	Apply listening skills to practice.	3	80%	80%
Outcome 5	Employ reading skills to read the given text.	4	60%	50%
Outcome 6	Demonstrate the forms of writings	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	2	3			3	3	3		3			
Outcome 2					3	3		3	3	3		3			
Outcome 3								3	2	3		3			
Outcome 4										3		3			
Outcome 5								2	3	3		3			
Outcome 6								3	3	3		3			
Average			**2**	**2**	**3**	**3**		**2.8**	**2.8**	**3**		**3**			

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	COs Addressed	References Used
Unit No. 1		**7**		
	Course Introduction and Overview	1	**1,2,3**	
	Parts of Speech	1		**1,2**
	Tenses	1		**1,2**
	Vocabulary (Etymology, Prefixes, Suffix)	2		**1,2**
	Capitalization & Punctuations	1		**1,2**
	Principles of Sentence Structure & Paragraph Writing (*S+V+O*)	1		**1,2,3**
Unit No. 2		**6**		
	The Fundamentals of Speech (*Ethos, Pathos & Logos*)	1	**1,2**	**1,2**
	How to give a good Speech? (*Rhetoric & Speech Delivery*)	1		**1,2**
	Verbal Communication (Turn taking strategies, Questioning, Types of Qs)	2		**1,2**
	Nonverbal Communication (Cultural Contexts, Importance and Types)	1		**1,2**
	Fundamentals of Personal, Informative, and Scientific Speech	1		**1,2**
Unit No. 3		**10**		
	Listening Skills: Definition, Barriers, Steps to Overcome	2	**4**	**2**
	Listening Comprehension	3		**2**
	Listening to Influence, Negotiate	2		**2**
	Listening to Specific Information	1		**2**
	Note taking & Making while Listening	2		**2**
Unit No. 4		**10**		
	Read to Skim, and Scan	2	**5**	**1,2**
	Read to Comprehend (Predict, Answer Questions & Summarize)	2		**1,2**
	Read to Appreciate, Compose and Present	3		**1,2**
	Read to Understand Referencing Skills for Academic Report Writing and Plagiarism (APA 6th Ed)	3		**1,2**
Unit No. 5		**12**		
	Write to Interpret Data (Flow charts, Bar Diagrams)	2	**6**	**4**
	Write to Inform (News, Emails, Notice, Agenda & Minutes)	2		**4**
	Write to Define (Definitions & Essays)	2		**4**
	Resume and Cover Letter	2		**4**
	Write an Effective Abstract and a Comprehensive Summary	2		**4**
	Write Project Proposal	2		**4**
Total Contact Hours		**45**		

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	40%		50%		30%		40%		50%	
	Understand										
Level 2	Apply	60%		50%		70%		60%		50%	
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100%**		**100%**		**100%**		**100%**		**100%**	

Recommended Resources

1. Shoba, Lourdes. (2017). Communicative English: A Workbook. U.K: Cambridge University Press.
2. Steven, Susan, Diana. (2015). Communication: Principles for a Life Time. U.S.A: Pearson 6th Ed.
3. Publication Manual of the American Psychological Association, (2010). 6th Ed.
4. Kosslyn, S.M. "Understanding Charts and Graphs", Applied Cognitive Psychology, vol. 3, pp. 185-226, 1989.

Other Resources

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Introduction to Environmental Science

Course Code	ENV 100	**Course Category**	FIC	**L**	**T**	**P**	**C**
				4	0	0	4
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Environmental Science	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To study the scope of Environmental Science and the idea of sustainability.
2. To acquire basic knowledge of environmental ethics, critical environmental laws, and policies.
3. To explore various sources and challenges in the renewable energy sector in replacing conventional 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	Recognise the scope and purview of Environmental Science, the Idea of sustainability, environmental ethics, and global efforts to overcome the hindrance for sustainability.	2	80%	70%
Outcome 2	Interpret the environmental laws and policies.	3	80%	70%
Outcome 3	Investigate climate change, the way it affects life at different scales (global, regional, and local scales), and various mitigation strategies.	2	70%	60%
Outcome 4	Analyse the extent of environmental pollution and pollution reduction strategies through and resource optimization, renewable energy, and waste management.	3	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	1	1	-	1	1	-	-	-
Outcome 2	1	-	1	-	1	-	3	-	1	-	1	1	-	-	-
Outcome 3	1	-	-	-	1	-	3	-	1	-	1	1	-	-	-
Outcome 4	1	-	-	-	1	-	3	-	1	-	1	1	-	-	-
Average	**1**	**-**	**1**	**-**	**1**	**-**	**3**	**1**	**1**	**-**	**1**	**1**	-	-	-

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	**Fundamental Concepts in Environmental Science**	**12**	1	1, 2, 3, 4, 5, 6, 7, 8, 10
	Human population and environment	1		
	Environmental education and awareness Environmental ethics Evolution of Environmental ethics – Leopold's land ethics, Silent Spring	2		
	Population growth, Ecological overshoot, and Ecological Footprint	2		
	Defining global sustainability, Garret Hardin's "Tragedy of the Commons', Brundtland commission report, Principles of sustainable development, Sustainable Development Goals (SDGs), Triple bottom line of sustainable development	2		
	Technology and Society: Information Technology - Human health & Environmental health, Environmental misconception	2		
	Sustainable ethics: Overcoming the obstacles of sustainability Individualizing Responsibility for a sustainable future - Consumption and its impact on sustainable development	3		
Unit No. 2	**Social issues and Environment**	**10**	4	1, 3, 9
	Fronterism, Biological Imperialism, and Natural rights, Significance of Human rights; Human rights and environment	3		
	Wastewater reclamation, Water conservation, Rainwater harvesting, Watershed management, Urban problems related to energy, Nuclear accidents	3		
	Global Environmental Policy, Environmental acts and laws, Water Act 1974, Environmental Protection Act 1986	4		
Unit No. 3	**Global Climate Change**	**14**	3	10, 3
	Differentiating Climate and Weather, Interconnection of Earth systems (Hydrosphere, Geosphere, Cryosphere, Atmosphere, and Biosphere)	2		
	Climate change through data (global temperature, and CO_2 – Mauna Lao Earth observatory)	3		
	Climate change: Impacts - Extreme weather events, Sea-level rise, Food and water security, and Human health & well-being, Biodiversity loss	4		
	Climate change: Adaptation – local to global scales, Synthesis	2		
	Disaster management – landslides, Tsunamis floods, earthquakes, anthropogenic disasters, Bhopal tragedy	2		
	Communicating climate change	1		
Unit No. 4	**Energy and Environment**	**8**	4	3, 4
	Renewable Energy: Global Status and trends	2		
	Global Renewable Energy Applications	2		
	Technical Issues, Challenges & Opportunities Solar, tidal, hydropower, Bioenergy, nuclear	2		
	Renewable Energy Markets	2		
Unit No. 5	**Environmental Pollution and Management**	**16**	2, 4	3, 11
	Pollution: Air pollution, Noise pollution, Water pollution, Soil pollution	4		
	Solid waste management: Collection, Handling, and solid waste management rules	4		
	E-waste and hazardous waste management, biomedical waste management	4		
	Wastewater treatment systems: Industrial and sewage treatment	4		

Learning Assessment

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

Recommended Resources

1. Daniel D. Chiras (2012), Environmental Science 9th Edition. Jones & Barlet Publishers
2. Carson, R. (2002). Silent spring. Houghton Mifflin Harcourt.
3. Rajagopalan, R (2015). Environmental Science – from crisis to cure, 3rd Edition. Oxford Higher Education.
4. Walter K Dodds (2018). Humanity's Footprint: Momentum, Impact, and Our Global Environment. Columbia University Press
5. Hayley Stevenson (2018). Global Environmental Politics Problems, Policy and Practice. Cambridge University Press
6. Garette Hardin (1968). The Tragedy of the Commons. Science 162 (3859), 1243-1248. DOI: 10.1126/science.162.3859.1243
7. Brutland Commission Report, 1987. Oxford University Press
8. TRANSFORMING OUR WORLD: The 2030 Agenda for Sustainable Development
9. Shastri, S.C. (2015) Environmental Law by 5th edition, EBC Publications.
10. Intergovernmental Panel on Climate Change (IPCC) Synthesis Report, 2014.
11. C.S. Rao (2018) Environmental Pollution Control Engineering, New Age International Publishers.

Other Resources

1. W. Cunningham, M. Cunningham (2016). Principles of Environmental Science (8th Edition), McGraw-Hill
2. Divan Shyam (2002). Environmental Law and Policy in India, OUP India
3. Jonathan Cowie, (2002). Climate change: Biological and Human Aspects, 2nd Edition. Cambridge University Press
4. Hanjalic, Kemo, Roel Van de Krol, and Alija Lekic, eds. (2017). Sustainable energy technologies: options and prospects. Springer Science & Business Media

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Mathematical Physics

Course Code	PHY 111	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 Lifelong 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

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Classical and Modern Physics

Course Code	PHY 112	**Course Category**	CC	**L**	**T**	**P**	**C**
				3	0	0	3
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 Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	2	3	1	2		-		2		2	3	2	2
Outcome 2	3	3	2	3	1	-		-		2		2	3	2	2
Outcome 3	3	3	2	3	2	-		2	2	2		2	3	2	2
Outcome 4	3	3	3	3	2	-	-	2	2	2		3	3	2	2
Outcome 5	3	3	3	3	2	3		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
6	X-ray diffraction on NaCl	6	1,5	7
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. 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).

Other Resources

1. 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/
2. Department of Physics, SRM University AP. Engineering Physics lab manuals. Retrieved from Engineering Physics Lab (FIC102) https://srmap.edu.in/seas/physics-teaching-lab/

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Physics Lab I

Course Code	PHY 113L	**Course Category**	CC	**L**	**T**	**P**	**C**
				0	0	1	1
Pre-Requisite Course(s)	PHY 111	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Physics	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Correlate classical mechanics theories with real life examples
2. Do Numerical simulation using C/Python program
3. Handle advanced instruments involving primarily damped and coupled oscillation
4. Be able to experimentally calculate important and advanced classical mechanics concepts like Young's modulus, rigidity modulus, moment of inertia etc. of a given material

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	State the consequences of quantization of electronenergy.	1	70%	65%
Outcome 2	Describe the spectroscopic techniques are built based on the fundamental principles and laws.	2	70%	65%
Outcome 3	Apply Lasers and Judge their power pertaining to their safety and hazards.	3	70%	65%
Outcome 4	Discuss the evolution of scientific experimentation techniques and its consequences in the modern technology.	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	3	2				3			2	3	2	3
Outcome 2	3	3	3	3	2				2			3	3	3	2
Outcome 3	3	3	3	3	2				3			3	3	3	3
Outcome 4	3	3	3	3	3				3			3	3	3	3
Average	**3**	**3**	**3**	**3**	**2**				**3**			**3**	**3**	**3**	**3**

Course Unitization Plan

Sl. No.	Description of experiments	Required Contact Hours	CLOs Addressed	References Used
1	Using classical energy conservation law, determine the moment of inertia of a flywheel	4	1	1,2
2	To record the Franck-Hertz characteristic curve for neon emission	4	1, 2	1, 2
3	. To determine the wavelengths of Balmer series in the visible region from Ar-atomic emission . To determine the Rydberg constant	4	2	1, 2
4	To determine Planck's Constant by Cs Photocell	4	2, 3	1, 2
5	Determine charge of an electron using Millikan's Oil Drop method	4	2, 3	1, 2
6	Plotting linear graph using python	4	3, 4	1, 2
7	To develop numerical formalism for flight of missiles and freely falling body on Earth's surface on C/python platform	4	3, 4	1, 2
8	To develop numerical formalism for motion of charge particles in electric and magnetic fields	4	I,O	1,2
	Total contact hours (Experiments +Demo + Extra class)	**32**		

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%
	Understand								70%		
Level 2	Apply		40%		60%						50%
	Analyse								30%		
Level 3	Evaluate										
	Create										
Total			**100%**		**100%**				**100%**		**100 %**

Recommended Resources

1. K.G. Mazumdar and B. Ghosh, "Advanced Practical Physics" Sreedhar Publishers, Revised edition Jan 2004.
2. R.K. Shukla and Anchal Srivastava, "Practical Physics" New Age international (P) limited Publishers, 2006 [ISBN(13) – 978-81-224-2482-9]
3. Hugh D.Young, Roger A. Freedman and Lewis Ford "University Physics with Modern Physics" (12th Edition, 2015) –(Publisher – Pearson Education)

Other Resources

1. http://www.atomic.physics.lu.se/education/mandatory-courses/fystc11-atomic-and-molecular-physics-for-science-faculty/laboratory-exercises/

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Wave and Oscillations

Course Code	PHY 116	**Course Category**	CE	**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
	Sound and Doppler Effect	**9**		

Unit No. 4	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 it's 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.	5	4, 5	1,2,8

	Find the velocity of sound in air at different temperature.			
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	5	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.

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Analytical Skills For Sciences

Course Code	AEC 106	**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	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 Aptitude from company specific and other competitive tests.	3	80%	70%
Outcome 3	Understand and solve puzzle questions from specific and other competitive tests	1	70%	60%
Outcome 4	Make sound arguments based on mathematical reasoning and careful analysis of data.	1	90%	80%

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			2		2		1			
Outcome 2		2			3			3	3						
Outcome 3		3							2			2			
Outcome 4								2	3			2			
Average		2.5			2			2.3	2.3	2		1.6			

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	**Quantitative Aptitude**			
	Data interpretation – Introduction and basics to solve data interpretation	4	1,4	1,4
	Data interpretation line graphs, Data interpretation bar graph.	6	1,4	1,4
Unit No. 2	**Quants**			
	Data interpretation – Pie charts,	2	1,4	1,4
	Data interpretation – Tabular, Data interpretation – case lets.	2	1,4	1,4
Unit No. 3	Statistics	6	1,2	2,3
Unit No. 4	Functions and graphs	3	1,2	1,2
	graph theory with respect to coding	2	1,2	1,2
	math graph theory and coding problems	2	2,3	2,3
	discrete planar theory and coding problems.	3	1,2	2,4
Total Contact Hours		**30**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (10%)		Mid-1 (15%)		CLA-2 (10%)		Mid-2 (15%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	40%		50%		40%		50%		50%	
	Understand										
Level 2	Apply	60%		50%		60%		50%		50%	
	Analyse										
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.

Other Resources

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Digital Literacy

Course Code	SEC 102	**Course Category**	SEC	**L**	**T**	**P**	**C**
				1	1	0	2
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 project 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 Muhtaris (Author)

Other Resources

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Introduction to Optics

Course Code	PHY 201	**Course Category**	Core	**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 Lifelong 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 $\mu\ vs.1/\lambda^2$ 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

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Advanced Mathematical Physics

Course Code	PHY 202	**Course Category**	Core	**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
Unit No. 5	**Tensors**	**12**		
	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

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Quantum Mechanics

Course Code	PHY 203	**Course Category**	Core	**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 *e.g.*, 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
	Schr**ö**dinger time dependent equation	1	3	1,2,6
	Tutorial II: Operator and wavefunction	1	1,3	1,2,6
	Schr**ö**dinger 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. Aruldhas, 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=PLUl4u3cNGP61-9PEhRognw5vryrSEVLPr
6. YouTube. (2023). Introduction to Quantum Mechanics. 1st ed, USA: YouTube. Retrieved from https://www.youtube.com/playlist?list=PLE0334305C5C04C30

Other Resources

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

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

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Electrostatics and Electric Current

Course Code	PHY 204	**Course Category**	Core	**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 Lifelong Learning	PSO 1	PSO 2	PSO 3
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

Other Resources

1. 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/

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Heat and Thermodynamics

Course Code	PHY 205	**Course Category**	Core	**L**	**T**	**P**	**C**
				3	0	1	4
Pre-Requisite Course(s)		**Co-Requisite Course(s)**	PHY 112L	**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 Lifelong Learning	PSO 1	PSO 2	PSO 3
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

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Electrodynamics

Course Code	PHY 206	**Course Category**	Core		**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 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 Lifelong 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
	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

Unit No. 4	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

Course Designer

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Analog and Digital Electronics

Course Code	PHY 207	**Course Category**	Core	**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	PSO 3
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. 1	**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
	n and *p-type* 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. 2	**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. 3	**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. 4	**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. 5	**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

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Solid State Physics

Course Code	PHY 301	**Course Category**	Core	**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

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Statistical Physics

Course Code	PHY 302	**Course Category**	Core	**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%

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	1	
Outcome 2	3	3	3	2	2			2	2	1		1	3	2	1
Outcome 3	3	3	2	3								2	2	2	3
Outcome 4	3	2	3	1				2	2	2		3	3		2
Average	3.0	2.8	2.5	2.3	1.5			2.0	2.0	1.5		2.0	2.5	1.7	2.0

Course Unitization Plan

Unit No.	Description of Topic	Required Contact hours	CLOs Addressed	Reference Used
Unit No. 1	**Elementary statistical concepts and examples**	**12**		
	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
	Tutorial – I	1	1,3	1,2,3
	Simple random walk problem in one dimension	1	1	1,2,3
	Problems on random walks (Tutorial II)	1	1,3	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
	Tutorial – III	1	1,3	1,2,3
Unit No. 2	**Statistical descriptions of systems of particles**	**12**		
	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
	Tutorial – IV	1	2,3	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
	Tutorial – V	1	2,3	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
	Tutorial – VI	1	2	1,2,3
Unit No. 3	**Statistics of Macroscopic systems**	**12**		
	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
	Tutorial – VII	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
	Tutorial – VIII	1	2,3	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
	Tutorial – IX	1	2,3	1,2,3
	Equipartition theorem	**12**		
	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
	Tutorial – X	1	2,3	1,2,3

Unit No. 4	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
	Tutorial – XI	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
	Tutorial – XII	1	3	1,2,3
Unit No. 5	**Quantum Statistics**	**12**		
	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
	Tutorial – XIII	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
	Tutorial – XIV	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
	Tutorial – XV	1	1,4	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 %)		**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. Bransden, B. H., & Joachain, C. J. (Year). Physics of Atoms and Molecules, 2nd ed. Pearson Education India.
2. Mandl, F. (2003). Statistical Physics, 2nd ed. Wiley.
3. Pathria, R. K. (Year). Statistical Mechanics, 2nd ed. Publisher

Other Resources

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Atomic and Molecular Physics

Course Code	PHY 303	**Course Category**	Core	**L**	**T**	**P**	**C**
				3	0	1	4
Pre-Requisite Course(s)	PHY 313	**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
	j-j 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
	Atomic and Molecular spectroscopy	**9**		
	Electromagnetic Wave: Property and Propagation	1	1	2, 3
	EM Wave Spectra and Microwave	1	1	2, 3

Unit No. 4	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
4. Brooks, R. L. (2013). The Fundamentals of Atomic and Molecular Physics, 1st ed. Springer Verlag New York.
5. Bransden, B. H., & Joachain, C. J. (Year). Physics of Atoms and Molecules, 2nd ed. Pearson Education India.

Other Resources

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Special Theory of Relativity

Course Code	PHY 304	**Course Category**	Core	**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	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%**

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

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%**

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Nuclear and Particle Physics

Course Code	PHY 305	**Course Category**	Core	**L**	**T**	**P**	**C**
				3	1	0	4
Pre-Requisite Course(s)	PHY203, PHY302	**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, it's 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 Quadrupole 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

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

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

SRM University *AP*, Andhra Pradesh
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Guntur District, Mangalagiri, Andhra Pradesh – 522240.

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.

Other Resources

1. https://arxiv.org/
2. https://www.sciencedirect.com/
3. www.springer.com
4. https://onlinelibrary.wiley.com/
5. https://www.overleaf.com/learn/latex/Tutorials (For Latex)

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Research Project

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)

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 Lifelong 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	
		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

Other Resources

1. https://arxiv.org/
2. https://www.sciencedirect.com/
3. www.springer.com
4. https://onlinelibrary.wiley.com/
5. https://www.overleaf.com/learn/latex/Tutorials (For Latex)

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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	Apply error analysis with significant digits, find roots using bisection, Newton-Raphson, and secant methods.	3	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 Life Long 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%		60%				60%		30%	30%
	Analyse										
Level 3	Evaluate										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

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

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.

Other Resources

1. 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

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

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 Life Long 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., Nassoy, 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.

Other Resources

1. National Programme on Technology Enhanced Learning (NPTEL). (2020). Introduction to Soft Matter. Available at: https://onlinecourses.nptel.ac.in/noc20_me05/preview.

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

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)

1. To introduce the basics of Astrophysics such as Astronomical coordinate system, distance and mass measurement techniques, stellar radiation
2. To discuss the stellar structure, stellar spectra, and stellar evolution
3. 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: ● 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
8. https://labcit.ligo.caltech.edu/~ajw/gwaves_review.pdf
9. https://indico.cern.ch/event/806259/attachments/1922819/3186014/CERN_Academic_Lecture_1_Jo_van_den_Brand.pdf
10. https://indico.cern.ch/event/806260/attachments/1923785/3186015/CERN_Academic_Lecture_2_Jo_van_den_Brand.pdf
11. https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.116.061102
12. https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.119.161101
13. https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.125.101102

Other Resources

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

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.
6. Tanner, B. K. (1996). Introduction to the Physics of Electrons in Solids (1st ed.). Boston, MA: Addison-Wesley.
7. Pierret, R. F. (1996). Semiconductor Device Fundamentals (4th ed.). Boston, MA: Addison-Wesley.

Other Resources

1. IIT Madras. (2021). Characterization of Materials. N/A, Online: NPTEL. Source Link: https://nptel.ac.in/courses/113/106/113106062/
2. 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/

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

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.	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	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%				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. Schroder, D. K. (2015). Semiconductor Material and Device Characterization, 3rd ed., Hoboken, NJ: Wiley-Interscience.
2. Rudolph, M. (2011). Microelectronic Test Structures for CMOS Technology, Latest Edition, Berlin: Springer.
3. Amerasekera, E. A., & Najm, F. N. (1997). Failure Mechanisms in Semiconductor Devices, 2nd ed., Piscataway, NJ: Wiley-IEEE Press.

Other Resources

1. IIT Madras. (2021). Characterization of Materials. N/A, Online: NPTEL. https://nptel.ac.in/courses/113/106/113106062/
2. 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/

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

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**	**2.6**	**2.33**	**2.25**	**2.67**				**2**	**2**		**2.2**	**2.4**	**2**	**2**

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
	Diffractive 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%		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

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

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

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

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

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

Other Resources

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

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

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

1. Webb, J. N. (2007). Game Theory. Springer Undergraduate Mathematics Series. London: Springer. https://doi.org/10.1007/978-1-84628-636-0
2. 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
3. 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

1. 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
2. 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
3. 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
4. Wang, H. (n.d.). Quantum Game Theory. Retrieved from http://math.uchicago.edu/~may/REU2022/REUPapers/Wang,Haoshu.pdf

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

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 $LiMn_2O_4$	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 spectroscpy	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. Zaghib. 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/

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

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

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

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.

Other Resources

1. 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

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

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

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

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	Validate quantum algorithms and concept of quantum key distribution	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	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%	30%	30%	30%			30%	30%	30%	30%
	Analyse										
Level 3	Evaluate		20%		20%				20%		20%
	Create										
Total		**60%**	**40%**	**60%**	**40%**			**100%**		**60%**	**40 %**

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

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

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)

1. To understand the concept of combinatorial optimizations problem and the usefulness of quantum annealing in those problems.
2. To apply the concepts of quantum annealing in model systems.
3. 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	Verify the performance benchmarking and trajectory towards quantum supremacy and beyond	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	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%	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. 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.

Other Resources

1. NPTEL. (n.d.). Quantum computing. Retrieved from https://elearn.nptel.ac.in/shop/iit-workshops/completed/quantum-computing/?v=c86ee0d9d7ed
2. YouTube. (n.d.). Quantum Computing: Explained with a deck of cards. Retrieved from https://www.youtube.com/watch?v=H9f7XHCHNxc

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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	PSO 3
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

Course Designers