ACADEMIC CURRICULUM AND SYLLABI

UNDERGRADUATE DEGREE PROGRAMME

BACHELOR OF SCIENCES

B.Sc. PHYSICS

Three Years (Full-Time)

National Education Policy - 2020

(For the Students Admitted from the Academic Year 2023 onwards)

DEPT. OF PHYSICS

SCHOOL OF BASIC SCIENCES

(Estd. Under SRMUS Act, 2013)

Shri Ramasamy Memorial University Sikkim
5th Mile, Upper Tadong, Gangtok, East Sikkim- 737102, India

DEPARTMENT OF PHYSICS

1. **Department Vision**	
1	*Aiming high-quality education and cutting-edge research in fundamental and advanced areas of Physics, as well as in inter-disciplinary areas.*
2	*Aiming at creating and developing competent and skilful Physicists, with a potential to engage in diverse fields, pertaining to Research/Academia/Industry.*
3	*Aiming to create a scientific society which encourages logical and Critical Thinking and Problem solving amongst the northeastern region and other parts of the country.*

2. **Department Mission**	
1	*To enable learners to acquire a comprehensive knowledge and sound understanding of fundamentals of Physics.*
2	*To acquire a range of mathematical & Lifelong learning, and to enhance the faculty of Critical Thinking and Problem Solving, and logical reasoning amongst the learners; communicating effectively with society and learn independently.*
3	*To expose the learners to contemporary research within various fields of Physics, which would ensure the grooming of graduate students into future researchers/scientists.*
4	*To enable the learners to acquire jobs efficiently in diverse fields in research/academia/industry, lay the rigorous foundation for higher and professional learning.*
5	*To imbibe a sense of commitment to professional Innovation and Entrepreneurship and generate a scientific temper in the society, and to apply knowledge of Physics towards environmental & sustainable development.*

3. **Program Objectives (PO)**	
PO1	To assist students in gaining comprehensive insight and comprehension of both foundational principles and advanced concepts in the field of Physics.
PO2	To introduce students to a variety of fundamental and advanced experiments across diverse areas of Physics, fostering the development of analytical, logical, and mathematical skills. This exposure aims to enhance their understanding of the latest technological advancements in Physics and related fields.
PO3	To empower learners to cultivate Critical Thinking and Problem Solving and scientific proficiency within a multidisciplinary setting, aiming to prepare them for lifelong learning while instilling a scientific temperament and ethical values amongst the northeastern region and other parts of the country.
PO4	To improve their employability across various sectors including academia, science, engineering, and public services, among others, while establishing a solid foundation for further professional and higher education.
PO5	To empower students to communicate effectively within the scientific community, facilitating the expression of their scientific and research ideas with clarity and precision.
PO6	To familiarise learners with the fundamental principles of physics within an environmental context, fostering an understanding of the discipline's relevance to sustainable development.

4. **Consistency of PO with Mission of the Department**					
	Mission Stmt. - 1	Mission Stmt. - 2	Mission Stmt. - 3	Mission Stmt. - 4	Mission Stmt. - 5

PO - 1	H	H	H	H	H
PO - 2	H	H	H	H	H
PO - 3	H	H	H	H	H
PO - 4	H	H	H	H	H
PO - 5	H	H	H	H	H
PO - 6	H	H	H	H	H

H – High Correlation, M – Medium Correlation, L – Low Correlation

5. Consistency of PO with Program Learning Outcomes (PLO)

	Program Learning Outcomes (PLO)										
	1.	2.	3.	4.	5	6.	7.	8.	9.	10.	11.
	Domain Specific Knowledge	Critical Thinking and Problem Solving	Inter and Multi-disciplinary Skills	Lifelong learning	Research Aptitude	Creativity	Communication Skills	Innovation and Entrepreneurship	Vocational and Industry Exposure	Environmental awareness and sustainability	Ethics
PO - 1	H	H	H	H	H	H	M	M	H	M	M
PO - 2	H	H	H	H	H	H	M	M	H	M	M
PO - 3	H	H	H	H	H	M	M	M	H	M	M
PO - 4	H	H	H	H	H	H	H	H	H	M	H
PO - 5	M	H	M	H	H	M	H	M	H	H	H
PO - 6	H	H	H	H	H	M	H	H	M	H	H

H – High Correlation, M – Medium Correlation, L – Low Correlation

6. B.Sc. Physics Program Structure (Total Credit: 120)

Core Courses (C)								
S.No	Course Category	Course Code	Course Name	L	T	P	L+T+P	C
		Theory						
1	C	PHY23CO11	Mechanical Properties of Matter and Acoustics	2	0	2	4	3
2		PHY23CO12	Classical Mechanics	2	1	0	3	3
3		PHY23CO21	Electricity & Magnetism	2	0	2	4	3
4		PHY23CO22	Mathematical Physics	2	1	0	3	3
5		PHY23CO31	Thermal Physics	3	0	2	5	4
6		PHY23CO32	Special Theory of Relativity	3	1	0	4	4
7		PHY23CO41	Quantum Mechanics	3	1	0	4	4
8		PHY23CO42	Modern Optics	3	0	2	5	4
9		PHY23CO43	Analog and Digital Electronics	3	0	2	5	4
10		PHY23CO51	Solid State Physics	3	0	2	5	4
11		PHY23CO52	Statistical Mechanics	3	1	0	4	4
12		PHY23CO53	Atomic Physics	3	0	2	5	4
13		PHY23CO54	Semiconductor Device	3	1	0	4	4
14		PHY23CO61	Nuclear Physics	3	1	0	4	4
15		PHY23CO62	Astrophysics	3	1	0	4	4

16		PHY23CO63	Nano Science	3	1	0	4	4
				Total Credit				60

Minor in Physics (MI)								
S.No	Course Category	Course Code	Course Name	L	T	P	L+T+P	C
1	MI	PHY23MI11	Introduction to Physics	2	0	2	4	3
2		PHY23MI21	Mathematical Physics	2	1	0	4	3
3		PHY23MI31	Waves and Oscillations	3	0	2	4	4
4		PHY23MI41	Introduction to Quantum Theory	2	1	0	3	3
5		PHY23MI42	Principle of Electronics	2	0	2	4	3
6		PHY23MI51	Concepts of Atomic Physics	3	1	0	4	4
7		PHY23MI61	Concepts of Nuclear and Particle Physics	3	0	2	5	4
				Total Credit				24

Minor in Mathematics and Computation (MI)								
S.No	Course Category	Course Code	Course Name	L	T	P	L+T+P	C
1	MI	MAA23MI11	Basic Algebra	2	1	0	3	3
2		MAA23MI21	Computational Calculus	2	0	2	4	3
3		MAA23MI31	Group Theory	3	1	0	3	4
4		MAA23MI41	Applied Statistics using Softwares	2	0	2	4	3
5		MAA23MI42	Real and Complex analysis	2	1	0	3	3
6		MAA23MI51	Differential Equations	3	1	0	4	4
7		MAA23MI61	Numerical Methods and Scientific	3	0	2	5	4

			Computing					
				Total Credit				24

Multidisciplinary (MD)								
S.No	Course Category	Course Code	Course Name	L	T	P	L+T+P	C
1	MD	PHY23MD11	Renewable Energy and Energy Harvesting	2	0	2	4	3
2		PHY23MD21	Physics of Everyday Life	2	0	2	4	3
3		PHY23MD31	Basics and Importance of Quantum Technology	2	0	2	4	3
				Total Credit				9

Skills Enhancement Courses (SEC)								
S.No	Course Category	Course Code	Course Name	L	T	P	L+T+P	C
1	SEC	PHY23SE11	Electrical Wiring and Maintenance	1	0	4	5	3
2		PHY23SE21	Solar Technology	1	0	4	5	3
3		PHY23SE31	Laboratory Theory and Practical	1	0	4	5	3
				Total Credit				9

Project (P)								
1	P	PHY23RP61	Project	0	0	8	8	4
				Total Credit				4

Ability Enhancement Courses (AEC)								
S.No	Course Category	Course Code	Course Name	L	T	P	L+T+P	C
1	AEC	UNI23AE01	Communicative English:Listening and Speaking Skills	1	0	2	3	2
2		UNI23AE02	Fundamentals of Computer	1	0	2	3	2
3		UN123AE 03	Communicative Skills: Reading and Writing Skills	1	0	2	3	2

4		UNI23AE02	Internet & Information Communication Technologies	1	0	2	3	2
				Total Credit				8

Value Added Courses (VAC)								
S.No	Course Category	Course Code	Course Name	L	T	P	L+T+P	C
1	VAC	UNI23VA03	Universal Human Values	1	0	4	5	3
2		UNI23VA11	Understanding India					
		UNI23VA11	Environmental science					
		UNI23VA05	NSS					
3		UN123VA01	Yoga Practices	1	0	4	5	3
				Total Credit				6

Course Structure								
Semester	**C**	**MI**	**MD**	**SEC**	**AEC**	**VA**	**P**	**Total Credits**
SEM I	2	1	1	1	1	1	-	20
SEM II	2	1	1	1	1	1	-	20
SEM III	2	1	1	1	1	-	-	20
SEM IV	3	2	-	-	1	-	-	20
SEM V	4	1	-	-	-	-	-	20
SEM VI	3	1	-	-	-	-	1	20
Total Credit	**60**	**24**	**9**	**9**	**8**	**6**	**4**	**120**

B.Sc Physics Honours with Research (Additional 40 Credits)

Course Structure								
Semester	**C**	**MI**	**MD**	**SEC**	**AEC**	**VA**	**P**	**Total Credits**

SEM I	5	-	-	-	-	-	-	20
SEM II	-	-	-	-	-	-	3	20
Total Credit	**20**						**20**	**40**

7. **Implementation Plan**

B.Sc. Physics Curriculum

Year I							
Semester	**Course Category**	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
Semester I	**Core**	PHY23CO11	Mechanical Properties of Matter and Acoustics	2	0	2	3
		PHY23CO12	Classical Mechanics	2	1	0	3
	Minor	MI11	Minor I				3
	Multidisciplinary	MD11	Multidisciplinary I				3
	AEC	AE11	AEC - 1				2
	SEC	PHY23SE11	Electrical Wiring and Maintenance	1	0	4	3
	Value Added Course	VA11	Value Added Course I				3
			Total Credit				**20**
Semester II	**Core**	PHY23CO21	Electricity and Magnetism	2	0	2	3
		PHY23CO22	Mathematical Physics	2	1	0	3
	Minor	MI21	Minor II				3
	Multidisciplinary	MD21	Multidisciplinary II				3

	AEC	AE21	AEC - 2				2
	SEC	PHY23SE21	Solar Technology	1	0	4	3
	Value Added Course	VA21	Value Added Course II				3
			Total Credit				**20**

Year II							
Semester	**Course Category**	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
Semester III	**Core**	PHY23CO31	Thermal Physics	3	0	2	4
		PHY23CO32	Special Theory of Relativity	3	1	0	4
	Minor	MI31	Minor III				4
	Multidisciplinary	MD31	Multidisciplinary III				3
	AEC	AE31	AEC – 3				2
	SEC	PHY23SE31	Laboratory Theory and Practical	1	0	4	3
			Total Credit				**20**
Semester IV	**Core**	PHY23CO41	Quantum Mechanics	3	1	0	4
		PHY23CO42	Modern Optics	3	0	2	4
		PHY23CO43	Analog and Digital Electronics	3	0	2	4
	Minor	MI41	Minor IV				3
		MI42	Minor V				3

	AEC	AE41	AEC - 4				2
			Total Credit				**20**

Year III							
	Course Category	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
Semester V	**Core**	PHY23CO51	Solid State Physics	3	0	2	4
		PHY23CO52	Statistical Mechanics	3	1	0	4
		PHY23CO53	Atomic Physics	3	0	2	4
		PHY23CO54	Semiconductor Device	3	1	0	4
	Minor	MI51	Minor VI				4
			Total Credit				**20**
Semester VI	**Core**	PHY23CO61	Nuclear Physics	3	1	0	4
		PHY23CO62	Astrophysics	3	1	0	4
		PHY23CO63	Nano Science	3	1	0	4
	Minor	MI61	Minor VII	3	1	0	4
	Project	PHY23RP61	Project	0	0	8	4
			Total Credit				**20**

Year IV							
	Course Category	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
Semester VII	**Core**	UNI23RP71	Research Methodology	2	0		4
		UNI23RP72	Data Analytics & Statistical Applications	2	0		4
		UNI23RP73	Scientific Writing and Research Ethics	3	0		4
		PHY23RP71	Domain Specific Research Paper I	3	0		4
		PHY23RP72	Domain Specific Research Paper II	3	0		4
			Total Credit				**20**
Semester VIII	**Project**	UNI23RP81	Research Project	0	0		12
		UNI23RP82	Presentation and Viva Voce	0	0		4
		UNI23RP83	Research Paper and Dissertation	0	0		4
			Total Credit				**20**

8. Program Articulation Matrix											
Course Name	Program Learning Outcomes										
	Domain Specific Knowledge	Critical Thinking and Problem Solving	Inter and Multi disciplinary Skills	Lifelong learning	Research Aptitude	Creativity	Communication Skills	Innovation and Entrepreneurship	Vocational and Industry Exposure	Environmental awareness and sustainability	Ethics

Mechanical Properties of Matter and Acoustics	H	H	H	H	H	M	-	-	H	H	M
Classical Mechanics	H	H	H	H	H	-	-	-	H	H	-
Electrical Wiring and Maintenance	H	H	H	H	H	-	M	-	H	H	H
Basic Algebra	H	H	H	H	H	-	-	-	H	H	-
Renewable Energy and Energy Harvesting	H	H	H	H	H	H	-	M	H	H	H
Introduction to Physics	H	H	H	H	H	-	M	M	H	H	M
Electricity & Magnetism	H	H	H	H	H	-	-	-	H	H	M
Mathematical Physics	H	H	H	H	H	-	-	-	H	H	H
Solar Technology	H	H	H	H	H	-	M	M	H	H	H
Mathematical Physics	H	H	H	H	H	-	-	-	H	H	-
Computational Calculus	H	H	H	H	H	-	-	-	H	H	H
Physics of Everyday Life	H	H	H	M	M	M	H	M	H	M	M
Thermal Physics	H	H	H	H	H	-	-	-	H	H	H
Special Theory of Relativity	H	H	H	H	H	M	-	-	H	H	-
Basics and Importance of Quantum Technology	H	H	H	H	H	-	H	M	H	H	H
Waves and Oscillations	H	H	M	M	H	H	-	M	H	M	M
Group Theory	H	H	H	H	H	-	-	-	H	H	H
Laboratory Theory and Practical	H	H	H	H	H	-	M	M	H	H	-
Quantum Mechanics	H	H	H	H	H	-	-	-	H	H	-
Modern Optics	H	H	H	H	H	-	M	M	H	H	H
Analog and Digital Electronics	H	H	H	H	H	-	M	M	H	H	H
Introduction to Quantum Theory	H	H	H	H	H	-	-	-	H	H	-
Principle of Electronics	H	H	H	H	H	-	M	M	H	H	H
Applied Statistics using Softwares	H	H	H	H	H	-	M	M	H	H	H
Real and Complex analysis	H	H	H	H	H	-	-	-	H	H	-
Solid State Physics	H	H	H	H	H	-	-	-	H	H	H
Statistical Mechanics	H	H	H	H	H	-	-	-	H	H	H
Atomic Physics	H	H	H	H	H	-	-	-	H	H	M

Semiconductor Device	H	H	H	H	H	-	M	M	H	H	H
Concepts of Atomic Physics	H	H	H	H	H	-	-	-	H	H	M
Differential Equations	H	H	H	H	H	H	-	-	H	H	-
Nuclear Physics	H	H	H	H	H	-	-	-	H	H	M
Astrophysics	H	H	M	M	H	-	-	-	M	M	M
Nano Science	H	H	H	H	H	-	M	M	M	H	H
Concepts of Nuclear and Particle Physics	H	H	H	H	H	M	-	-	H	H	M
Numerical Methods and Scientific Computing	H	H	H	H	H	M	-	-	H	H	H
Project	H	H	H	H	H	M	H	H	H	H	H

Semester I

Course Code	PHY23CO11	**Course Name**	*Mechanical Properties of Matter and Acoustics*	**Course Category**	*C*	*Core*	L	T	P	C
							2	0	2	3
Pre-requisite			None							

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	**Bloom's Learning (BL) Level**	**Program Learning Outcomes (PLO)**										
			PLO-1	**PLO-2**	**PLO-3**	**PLO-4**	**PLO-5**	**PLO-6**	**PLO-7**	**PLO-8**	**PLO-9**	**PLO-10**	**PLO-11**
			Domain Specific Knowledge	Critical Thinking and Problem Solving	Inter and Multi disciplinary Skills	Lifelong learning	Research Aptitude	Creativity	Communication Skills	Innovation and Entrepreneurship	Vocational and Industry Exposure	Environmental awareness and sustainability	Ethics
CLO-1	Define, classify and analyse elastic properties of matter	2	H	H	H	H	H	-	-	M	M	-	H
CLO-2	Develop the concepts about properties of fluid motion.	3	H	H	M	H	H	-	-	M	M	-	H
CLO-3	Incorporate the principles of surface tension.	3	H	H	M	H	H	-	-	M	M	-	H
CLO-4	Develop the understanding of waves and oscillations	3	H	H	H	-	H	M	-	-	M	-	H
CLO-5	Apply the	3	H	H	H								

	concepts and theories of acoustics to ultrasonics					H	H	M	-	M	M	-	H

(Level of correlation: ***3-High, 2-Medium, 1-Low*** can be used)

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
Unit 1	**ELASTICITY** Three types of elastic moduli and relation among them - Poisson's ratio- Bending of beams - Uniform - Non-uniform bending - Theory - Work done in uniform bending – Non-uniform bending - Determination of rigidity modulus. ● Determination of Young's modulus of the material of the beam – Uniform Bending (Pin and Microscope). ● Determination of Young's modulus of the material of the beam – Non-uniform bending (Pin and Microscope). ● Determination of rigidity modulus using Torsional Pendulum – Without masses. ● Determination of rigidity modulus using static torsion method.	6	CLO1
Unit 2	**FLUID MOTION** Viscosity - Coefficient of critical velocity – Poiseulli's formula for coefficient of viscosity and its correction - Stoke's method for the Coefficient of a highly viscous liquid - Viscosity of gases. ● Determination of coefficient of viscosity of liquid–Poiseuille's flow method.	6	CLO2
Unit 3	**SURFACE TENSION** Surface energy, relation between surface tension and surface, Angle of contact, Formation of drops.	6	CLO3
Unit 4	**SOUND** Definition of free, damped and forced vibrations - Fourier's theorem - Application for Saw-tooth wave and square wave -Sonometer. ● Determination of frequency using a Sonometer.	6	CLO4

Unit 5	**ULTRASOUND and ACOUSTICS** Ultrasonic- Production - Piezoelectric method - Properties - Applications. Acoustics: Intensity Level, Loudness - Acoustics of buildings - Reverberation - Sources of noises and its control - Sound level meter. ● Determination of acceleration due to gravity- Compound bar pendulum.	6	CLO4, CLO5

Additional 30 hours for Practical

Learning Resources	
Text Books	1. Brijlal and Subramaniam N., *Properties of Matter*, Revised Edition, S.Chand and Company, 2005. 2. Murugesan R., *Properties of Matter and Acoustics*, Revised Edition, S.Chand and Company, 2005.
Ref. Books	1. Landau L. D., Pitaevskii L P, Kosevich A M and Lifshitz E M, *Theory of Elasticity*, Revised Edition, Butterworth-Heinemann, 2014. 2. Landau L. D., Pitaevskii L P, Kosevich A M and Lifshitz E M, *Fluid Mechanics*, Revised edition, utterworth-Heinemann, 2014. 3. Saighal R. L, *A Text Book of Sound* , 5th Edition, S. Chand and Company, 2010. 4. Mathur D. S, *Elements of Properties of Matter*, 3rd Edition, S. Chand and Company, 2005. 5. Satyaprakash and Akash Saluja, *Oscillations and Waves*, Pragati Prakashan, 2002.

Learning Assessment											
	Bloom's Level of Thinking	**Continuous Learning Assessment (40% weightage)**								**Final Examination (60% weightage)**	
		CLA – 1 (10%)		**CLA – 2 (10%)**		**CLA – 3 (10%)**		**CLA – 4 (10%)**			
		Theory	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**
Level 1	Remember	**50%**	**50%**	**50%**	**50%**	**30%**	**30%**	**30%**	**30%**	**30%**	-
	Understand										-
Level 2	Apply	**50%**	**50%**	**50%**	**50%**	**40%**	**40%**	**40%**	**40%**	**40%**	-
	Analyze										-
Level 3	Evaluate	-	-	-	-	**30%**	**30%**	**30%**	**30%**	**30%**	-
	Create	-	-	-	-						-
		100%		**100%**		**100%**		**100%**		**100%**	-

Course Designers		
Experts from Industry: Name, Designation with official mail id	Experts from Higher Education Institutions: Name, Designation with official mail id	Internal Experts: Name, Designation with official id
Name: Dr. Jagdish Chandra Saraswatula *Designation : Director of Product Management, Brooks Automation, Germany* ***Email: Jagdish.saraswatula@gmail.com***	*ame: Prof. Prem Pal* *Designation: Professor, Indian Institute of Technology, Hyderabad.* ***Email: prem@iith.ac.in***	*Name: Dr. Nishal Rai* *Designation: Assistant professor, SRM University Sikkim* ***Email:nishalrai.g@srmus.edu.in***

Course Code	*PHY23C012*	**Course Name**	*Classical Mechanics*	**Course Category**	*C*	*CORE*	L	T	P	C
							2	1	0	3

Pre-requisite	**Nil**											

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	**Bloom's Learning (BL) Level**	**Program Learning Outcomes (PLO)**										
			PLO-1	**PLO-2**	**PLO-3**	**PLO-4**	**PLO-5**	**PLO-6**	**PLO-7**	**PLO-8**	**PLO-9**	**PLO-10**	**PLO-11**
			Domain Specific Knowledge	Critical Thinking and Problem Solving	Inter and Multidisciplinary Skills	Lifelong learning	Research Aptitude	Creativity	Communication Skills	Innovation and Entrepreneurship	Vocational and Industry Exposure	Environmental awareness and sustainability	Ethics
CLO-1	Define and comprehend the ideas frame of reference	2	H	H	H	H	H	H	H	-	-	-	H
CLO-2	Develop the concept for mechanics of a single particle	3	H	H	H	M	M	M	H	-	-	-	M
CLO-3	Apply the concept of mechanics of a particle to system of particles	3	H	H	H	M	H	M	H	-		-	H
CLO-4	Construct the Lagrangian and Hamilton formalism in classical mechanic	3	H	H	H	H	H	H	H	-	-	-	H

	s.												
CLO-5	Develop and apply the concepts of central force motion and Kepler problems.	3	H	H	H	H	M	-	H	-	-	-	H

(Level of correlation: ***3-High, 2-Medium, 1-Low*** can be used)

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
Unit 1	**FRAME OF REFERENCE** Frame of reference- Inertial frame of reference- Galilean transformation- Frame of reference with linear acceleration- Galilean invariance, non-inertial frames- Rotating frame of reference.	9	CLO1
Unit 2	**MECHANICS OF SINGLE PARTICLE** Mechanics of a single particle - Conservation of linear momentum- Conservation of Angular momentum - Mechanical energy for a particle -Centre of mass and equation of motion.	9	CLO2
Unit 3	**SYSTEM OF PARTICLES** Mechanics of system of particles- Conservation of linear momentum- Conservation of Angular momentum - Mechanical energy for system of particles-Centre of mass and equation of motion - Constrained Motion-Types of constraints-Forces of constraints - Principle of Virtual work –D'Alembert's principle.	9	CLO3
Unit 4	**LAGRANGE AND HAMILTONIAN MECHANICS** Degrees of freedom and generalized coordinates-Transformation Equations-Generalized Displacement-Generalized velocity- Generalized Acceleration-Generalized momentum-Generalized Force -Generalized Potential-Hamilton's Variational principle- Lagrange's equation of motion from Hamilton's principle-Linear Harmonic Oscillator-Simple pendulum-Atwood's	9	CLO4

	machine.		
Unit 5	**CENTRAL FORCE** Definition and properties of central force -Two body central force problem- Reduction to the equivalent one body problem-Equations of motion- Kepler's problem: Inverse square law of force -The motion in time in Kepler's Problem-Orbits of artificial satellites.	9	CLO5

Learning Resources	
Text Books	1. Rana N. C.and Joag P.S., *Classical Mechanics*, 1st Edition, McGraw Hill, 2011. 2. Herbert Goldstein, Charles P. Poole and John L. Safko, *Classical Mechanics*, 3rd Edition, Pearson, 2011.
Ref. Books	1. John R. Taylor, *Classical Mechanics*, 1st Edition, University Science Books, 2005. 2. David Morin, *Introduction to Classical Mechanics*, 1st Edition, Cambridge University Press, 2008. 3. Harald J. W. Muller-Kirsten, *Classical Mechanics and Relativity*, 1st Edition, World Scientific Publishing Ltd, 2008. 4. Dieter Strauch, *Classical Mechanics-An Introduction*, 5th Edition, Springer, 2009. 5. Frank H. Berkshire, T. W. B. Kibble and Tom W. B. Kibble, *Classical Mechanics*, 5th Edition, World Scientific Publishing Company, 2004.

Learning Assessment											
	Bloom's Level of Thinking	**Continuous Learning Assessment (40% weightage)**								**Final Examination (60% weightage)**	
		CLA – 1 (10%)		**CLA – 2 (10%)**		**CLA – 3 (10%)**		**CLA – 4 (10%)**			
		Theory	**Other Assessment**	**Theory**	**Other Assessment**	**Theory**	**Other Assessment**	**Theory**	**Other Assessment**	**Theory**	**Other Assessment**
Level 1	Remember	**50%**	**50%**	**50%**	**50%**	**30%**	**30%**	**30%**	**30%**	**30%**	**-**
	Understand										**-**
Level 2	Apply	**50%**	**50%**	**50%**	**50%**	**40%**	**40%**	**40%**	**40%**	**40%**	**-**
	Analyze										**-**
Level 3	Evaluate	-	-	-	-	**30%**	**30%**	**30%**	**30%**	**30%**	**-**
	Create	-	-	-	-						**-**
		100%		**100%**		**100%**		**100%**		**100%**	**-**

Course Designers		
Experts from Industry: Name, Designation with official mail id	Experts from Higher Education Institutions: Name, Designation with official mail id	Internal Experts: Name, Designation with official id
Name: Dr. Jagdish Chandra Saraswatula *Designation : Director of Product Management, Brooks Automation, Germany* ***Email: Jagdish.saraswatula@gmail.com***	*ame: Prof. Prem Pal* *Designation: Professor, Indian Institute of Technology, Hyderabad.* ***Email: prem@iith.ac.in***	*Name: Dr. Nishal Rai* *Designation: Assistant professor, SRM University Sikkim* ***Email:nishalrai.g@srmus.edu.in***

Course Code	PHY23SE11	Course Name	Electrical Wiring and Maintenance	Course Category	SEC	Skills Enhancement course	L	T	P	C
							1	0	4	3
Pre-requisite Nil				**Co-requisite**						

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO-1	**PLO-2**	**PLO-3**	**PLO-4**	**PLO-5**	**PLO-6**	**PLO-7**	**PLO-8**	**PLO-9**	**PLO-10**	**PLO-11**
			Domain Specific Knowledge	Critical Thinking and Problem Solving	Inter and Multi-disciplinary Skills	Lifelong learning	Research Aptitude	Creativity	Communication Skills	Innovation and Entrepreneurship	Vocational and Industry Exposure	Environmental awareness and sustainability	Ethics
CLO-1	Define, classify and analyse different components of Electrical circuit	2	H	H	M	H	H	H		H	M	M	H
CLO-2	Develop the concept on basic of house wiring	3	H	M	M	H	H	H		H	M	M	H
CLO-3	Comprehend the basic principles and idea of earthing	3	H	H	M	M	H	H		H	M	M	H
CLO-4	Develop the concept of maintenance of electrical applianc	3	H	H	H	H	H	H		H	M	M	H

	es.												
CLO-5	Apply the concepts and theories of electronics in the maintenance and repair of basic electrical appliances.	3	H	M	M	M	H	H		H	M	M	H

(Level of correlation: ***3-High, 2-Medium, 1-Low*** can be used)

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
Unit 1	**BASIC COMPONENTS OF ELECTRICAL CIRCUIT** Resistors, capacitors, inductors, and transformers. Electrical energy, Power, Power factor, Single-phase and three-phase connections, consumption of electrical power. ● Introduction with Electrical Symbols. ● Study of various passive components and measuring instruments and their connections in electrical circuits.	3	CLO1
Unit 2	**BASICS OF HOUSE WIRING** Introduction to wiring symbols used in single and three-phase electrical diagrams, Concept regarding correct techniques of interpreting electrical diagrams regarding electrical circuits, types of Cables, Connectors, Switches and their usage in different household applications. ● Verification of Ohm's Law.	3	CLO2
Unit 3	**EARTHING** Overloading, Earthing and its necessity, short-circuiting, Fuses, MCB, Earth Leakage Circuit Breaker (ELCB), Insulation, Inverter. ● Verification of equivalent resistances in series and parallel connections.	3	CLO3
Unit 4	**ELECTRONIC APPLIANCES AND ITS MAINTENANCE** Soldering technique, tools, breadboard and PCB, Types of	3	CLO4

	LED, LCD and various Display panels, P-N Junction diode, Zener diode, and voltage regulator ICs. ● Measurement of various characteristic values of a Sinusoidal waveform with the help of CRO		
Unit 5	**ELECTRICAL APPLIANCES AND SAFETY RULES** Principles of working, parts and servicing of Electric fan, Electric Iron box, Water heater; Induction heater, Electric bulbs, CFL, LED lights. Types of hazards involved in electrical connections, First Aid, Fire extinguisher, Safety drills, Types, and use of PPEs as per general and electrical safety norms ● Measurement of voltage, current and power in RL and RLC circuits and Verification of phase angle and power factor concept.	3	CLO5

Additional 60 hours for Practical

Learning Resources	
Text Books	1. A textbook in Electrical Technology - A K Theraja, B L Theraja - S Chand & Co. 2. Electrical Design Estimating And Costing by K.B. RAINA , Dr. S K Bhattacharya, New Age International (P) Ltd., Publishers 3. Electrical Wiring: An Introduction:2nd ed - Satheesh Kumar
Ref. Books	1. Performance and design of AC machines - M G Say ELBS Edn. 2. Residential Construction Academy House Wiring 4Ed (Hb 2016) by Fletcher G, Cengage Learning 3. Electrical Wiring: Design and Construction, Robert Carl Johnson, Prentice Hall

Learning Assessment												
	Bloom's Level of Thinking	**Continuous Learning Assessment (100% weightage)**								**Final Examination (0% weightage)**	
		CLA – 1 (25%)		**CLA – 2 (25%)**		**CLA – 3 (25%)**		**CLA – 4 (25%)**			
		Theory	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**
Level 1	Remember	**50%**	**50%**	**50%**	**50%**	**30%**	**30%**	**30%**	**30%**	-	-
	Understand									-	-
Level 2	Apply	**50%**	**50%**	**50%**	**50%**	**40%**	**40%**	**40%**	**40%**	-	-
	Analyze									-	-
Level 3	Evaluate	-	-	-	-	**30%**	**30%**	**30%**	**30%**	-	-
	Create	-	-	-	-					-	-
		100%		**100%**		**100%**		**100%**		-	-

Course Designers		
Experts from Industry: Name, Designation with official mail id	Experts from Higher Education Institutions: Name, Designation with official mail id	Internal Experts: Name, Designation with official id
Name: Dr. Jagdish Chandra Saraswatula *Designation : Director of Product Management, Brooks Automation, Germany* ***Email: Jagdish.saraswatula@gmail.com***	*ame: Prof. Prem Pal* *Designation: Professor, Indian Institute of Technology, Hyderabad.* ***Email: prem@iith.ac.in***	*Name: Dr. Nishal Rai* *Designation: Assistant professor, SRM University Sikkim* ***Email:nishalrai.g@srmus.edu.in***

Course	*PHY23MI11*	**Course**	*Introduction to Physics*	**Course Category**	*MI*	*Minor in Physics*	L	T	P	C
							2	0	2	3

Code		Name								
Pre-requisite Nil			Co-requisite							

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO-1	PLO-2	PLO-3	PLO-4	PLO-5	PLO-6	PLO-7	PLO-8	PLO-9	PLO-10	PLO-11
			Domain Specific Knowledge	Critical Thinking and Problem Solving	Inter and Multi disciplinary Skills	Lifelong learning	Research Aptitude	Creativity	Communication Skills	Innovation and Entrepreneurship	Vocational and Industry Exposure	Environmental awareness and sustainability	Ethics
CLO-1	Define, classify and analyse different kinds of motion	2	H	H	H	H	H	H	H	-	-	-	H
CLO-2	Develop the concept on properties of matter	3	H	H	H	H	H	H	H	-	-	-	M
CLO-3	Comprehend the basic principle heat, laws of thermodynamics and their applications	3	H	H	H	M	M	M	H	-		-	H
CLO-4	Develop the understanding of electricity and magnetism	3	H	H	H	H	H	H	H	-	-	-	H

CLO-5	Apply the concepts and theories of optics	3	H	H	H	M	M	H	H	-	-	-	H

(Level of correlation: ***3-High, 2-Medium, 1-Low*** can be used)

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
Unit 1	**SIMPLE HARMONIC MOTION AND CIRCULAR MOTION** Time period – Amplitude – Phase – Spring mass system – Simple pendulum – Uniform circular motion – Acceleration of a particle in a circle – Centripetal and centrifugal forces – Banking on curved roads ● Determination of Rigidity Modulus of a wire – Torsional pendulum	6	CLO1
Unit 2	**PROPERTIES OF MATTER** Elasticity and plasticity – Elastic constants – Bending of beams – Young's modulus by non – Uniform bending – Torsion in a wire – Determination of rigidity modulus of torsion pendulum – Viscosity – Coefficient of viscosity – Stoke's law – terminal velocity – Surface tension. ● Determination of Young's Modulus– Uniform bending Method ● Determination of Young's Modulus– Non Uniform bending Method	6	CLO2
Unit 3	**HEAT AND THERMODYNAMICS** Kinetic theory of gases – Basic postulates – Ideal gas laws – Van Der Waals equation of states – Pressure of an ideal gas – Laws of thermodynamics – Entropy – change of entropy in reversible and irreversible processes. ● Determination of thermal conductivity of a bad conductor using Lee's disc method	6	CLO3
Unit 4	**ELECTRICITY AND MAGNETISM**	6	CLO4

	Electric charge – Conservation of charge – Permittivity – Coulomb's law – Electric field – Electric potential – Gauss's law and its applications, Permeability – Susceptibility – Magnetic field due to a current carrying conductor – Biot Savart's law – Field along the axis of a coil – Ampere's circuital law – Faraday's law. ● Calibration of Voltmeter using potentiometer ● Calibration of Ammeter using potentiometer		
Unit 5	**GEOMETRICAL OPTICS** Light and Optics – Fermat's principle – Laws of reflection and refraction – Total internal reflection and its illustrations – Lens formula – Refraction through a prism – Defects of images – Coma distortion – Spherical and chromatic aberration in lenses. ● Determination of dispersive power of a prism using spectrometer ● Determination of Cauchy's constant using spectrometer	6	CLO5

Additional 30 hours for Practical

Learning Resources	
Text Books	1. Resnick R. and Halliday D., *Fundamentals of Physics*, Wiley Publication, 8th Edition, 2011 2. Sundaravelusamy A., *Allied Physics I*, Priya Publications, 2009.
Ref. Books	1. Naik P.V., *Principles of Physics*, PHI Learning Pvt. Ltd, 2006. 2. John Thiruvadigal D., Ponnusamy S., Sudha L. and Krishnamohan M. *Physics for Technologists*, Vibrant Publication, 2013. 3. Rajam J. B., *Physics for Technologists*, S. Chand, 1981. 4. Brijilal and Subramanian, *Elements of Properties of Matter*, S. Chand Limited, 2014 (Reprint).

Learning Assessment											
	Bloom's Level of Thinking	**Continuous Learning Assessment (40% weightage)**								**Final Examination (60% weightage)**	
		CLA – 1 (10%)		**CLA – 2 (10%)**		**CLA – 3 (10%)**		**CLA – 4 (10%)**			
		Theory	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**
Level 1	Remember	**50%**	**50%**	**50%**	**50%**	**30%**	**30%**	**30%**	**30%**	**30%**	-
	Understand										-
Level 2	Apply	**50%**	**50%**	**50%**	**50%**	**40%**	**40%**	**40%**	**40%**	**40%**	-
	Analyze										-
Level 3	Evaluate	-	-	-	-	**30%**	**30%**	**30%**	**30%**	**30%**	-
	Create	-	-	-	-						-
		100%		**100%**		**100%**		**100%**		**100%**	-

Course Designers		
Experts from Industry: Name, Designation with official mail id	Experts from Higher Education Institutions: Name, Designation with official mail id	Internal Experts: Name, Designation with official id
Name: Dr. Jagdish Chandra Saraswatula *Designation : Director of Product Management, Brooks Automation, Germany* ***Email: Jagdish.saraswatula@gmail.com***	*ame: Prof. Prem Pal* *Designation: Professor, Indian Institute of Technology, Hyderabad.* ***Email: prem@iith.ac.in***	*Name: Dr. Nishal Rai* *Designation: Assistant professor, SRM University Sikkim* ***Email:nishalrai.g@srmus.edu.in***

Course	*PHY23MD11*	**Course**	*Renewable Energy and Energy Harvesting*	**Course Category**	*MD*	*Multidisciplinary*	L	T	P	C
							2	1	0	3

Code		Name								
Pre-requisite Nil				Co-requisite						

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO-1	PLO-2	PLO-3	PLO-4	PLO-5	PLO-6	PLO-7	PLO-8	PLO-9	PLO-10	PLO-11
			Domain Specific Knowledge	Critical Thinking and Problem Solving	Inter and Multi-disciplinary Skills	Lifelong learning	Research Aptitude	Creativity	Communication Skills	Innovation and Entrepreneurship	Vocational and Industry Exposure	Environmental awareness and sustainability	Ethics
CLO-1	Define and classify alternative sources of energy	2	H	H	H	H	H	H	H	-	-	-	H
CLO-2	Develop the concepts of solar energy and its applications	3	H	H	H	M	M	M	H	-	-	-	M
CLO-3	Comprehend the concept geothermal and hydro energy	3	H	H	H	H	H	H	H	-		-	H
CLO-4	Develop the understanding of bioenergy	3	H	H	H	H	H	H	H	-	-	-	H

CLO-5	Apply the concepts and theories for energy harvesting	3	H	H	H	M	M	M	H	-	-	-	H

(Level of correlation: ***3-High, 2-Medium, 1-Low*** can be used)

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
Unit 1	**FOSSIL FUELS AND ALTERNATIVE SOURCES OF ENERGY** Fossil fuels and nuclear energy, their limitation, need of renewable energy, non-conventional energy sources. An overview of developments in Offshore Wind Energy, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy, tidal energy, and Hydroelectricity.	9	CLO1
Unit 2	**SOLAR ENERGY** Solar energy, its importance, storage of solar energy, solar pond, non-convective solar pond, applications of the solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar greenhouses, solar cell, absorption air conditioning.	9	CLO2
Unit 3	**GEOTHERMAL AND HYDRO ENERGY** Geothermal Resources, Geothermal Technologies, Hydropower resources, hydropower technologies, the environmental impact of hydropower sources, Carbon captured technologies, cell, batteries, power consumption	9	CLO3
Unit 4	**BIO-ENERGY** Bioenergy (energy produced by biofuels): bioenergy and sustainability, Energy density (definition only), Biomass as resources: Classification and estimation of biomass (sugarcane agro-industry, advantages and dangers of	9	CLO4

	energy farming), Source and characteristics of biofuels (production and uses), Biodiesel & Bio-ethanol (production from ethanol), Biogas, conversion of waste produce into energy		
Unit 5	**ENERGY HARVESTING** Wind Energy harvesting- Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces. Piezoelectric Energy harvesting – Introduction, Physics and characteristics of piezoelectric effect, Piezoelectric parameters and modeling piezoelectric generators, Piezoelectric energy harvesting applications, Linear generators, physics mathematical models, recent applications.	9	CLO5

Learning Resources	
Text Books	1. Non-conventional energy sources - G.D Rai - Khanna Publishers, New Delhi 2. Solar energy - M P Agarwal - S Chand and Co. Ltd.
Ref. Books	1. Solar energy - Suhas P Sukhative Tata McGraw - Hill Publishing Company Ltd. 2. Godfrey Boyle, “Renewable Energy, Power for a sustainable future”, 2004, Oxford University Press, in association with The Open University. 3. Dr. P Jayakumar, Solar Energy: Resource Assessment Handbook, 2009 4. J.Balfour, M.Shaw and S. Jarosek, Photovoltaics, Lawrence J Goodrich (USA).

Learning Assessment											
	Bloom's Level of Thinking	**Continuous Learning Assessment (100% weightage)**								**Final Examination (0% weightage)**	
		CLA – 1 (10%)		**CLA – 2 (10%)**		**CLA – 3 (10%)**		**CLA – 4 (10%)**			
		Theory	**Other Assessment**	**Theory**	**Other Assessment**	**Theory**	**Other Assessment**	**Theory**	**Other Assessment**	**Theory**	**Other Assessment**
Level 1	Remember	**50%**	**50%**	**50%**	**50%**	**30%**	**30%**	**30%**	**30%**	-	-
	Understand										-
Level 2	Apply	**50%**	**50%**	**50%**	**50%**	**40%**	**40%**	**40%**	**40%**	-	-
	Analyze										-
Level 3	Evaluate	-	-	-	-	**30%**	**30%**	**30%**	**30%**	-	-
	Create	-	-	-	-						-
		100%		**100%**		**100%**		**100%**		-	-

Course Designers		
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Semester II

Course Code	PHY23CO21	Course Name	Electricity and Magnetism	Course Category	C	Core	L	T	P	C
							2	0	2	3
Pre-requisite			None	**Co-requisite**						

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	**Bloom's Learning (BL) Level**	**Program Learning Outcomes (PLO)**										
			PLO-1	**PLO-2**	**PLO-3**	**PLO-4**	**PLO-5**	**PLO-6**	**PLO-7**	**PLO-8**	**PLO-9**	**PLO-10**	**PLO-11**
			Domain Specific Knowledge	Critical Thinking and Problem Solving	Inter and Multi-disciplinary Skills	Lifelong learning	Research Aptitude	Creativity	Communication Skills	Innovation and Entrepreneurship	Vocational and Industry Exposure	Environmental awareness and sustainability	Ethics
CLO-1	Comprehend the general concepts in Electrostatics and Electromagnetism	2	H	H	H	H	H	H	H	-	-	-	H
CLO-2	Identify and explain the chemical, thermal and magnetic effect of electric current analyze and solve electrical circuits with dc and ac sources	3	H	H	H	M	M	H	H	-	-	-	M
CLO-3	Develop and apply	3	H	H	H	H	H	M	H	-		-	H

	the basic ideas about the principles of Magnetism												
CLO-4	Comprehend and analyze the significance of Electromagnetic theory	3	H	H	H	H	H	H	H	-	-	-	H
CLO-5	Apply the analyze the Physics concepts to solving problems	3	H	H	H	M	M	M	H	-	-	-	H

(Level of correlation: ***3-High, 2-Medium, 1-Low*** can be used)

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
Unit 1	**ELECTROSTATICS AND DIELECTRICS** Electrostatic potential - Electric potential as line integral of electric field - Relation between electric potential and electric field in vector form - Gauss‟s Law and its applications – Gauss Divergence Theorem and differential form of Gauss‟s Law - Poisson‟s and Laplace‟s equations - Capacitance -Capacitance of a spherical and cylindrical capacitor - energy of a charged capacitor - Energy density- Loss of energy due to sharing of charges - Polarization in linear dielectric - Field inside a dielectric sphere in uniform electric field - Clausius-Mossotti Relation.	6	CLO1
Unit 2	**CURRENT ELECTRICITY** Current and current density - Equation of continuity – Ohm‟s law and electrical conductivity - Drude-Lawrence theory of electrical conduction - Kirchhoff‟s Laws - Carey	6	CLO1, CLO2

	Foster bridge. ● Calibration of voltmeter using Potentiometer. ● Calibration of ammeter using Potentiometer.		
Unit 3	**MAGNETIC EFFECTS OF ELECTRIC CURRENT** Ampere's circuital law (both in integral and differential form) and its application to simple systems viz., current carrying loop-solenoid-toroid - Biot-Savart‟s law and its application to simple systems viz., long straight wire carrying steady current-Circular loop carrying steady current - Solenoid - Helmholtz Galvanometer ● Comparison of emf of two given primary cells.	6	CLO3
Unit 4	**ELECTROMAGNETIC INDUCTION** Laws - Lenz‟s laws- Integral and differential forms of Faraday‟s law– Mutual and Self Inductance-Determination of self-inductance by Anderson‟s bridge method and absolute mutual inductance by BG-Ruhmkorff‟s induction coil.	6	CLO4
Unit 5	**TRANSIENT AND ALTERNATING CURRENT** Growth and decay of current in a circuit containing resistance and inductance - Growth and decay of charge in a circuit containing resistance and capacitor-Measurement of high resistance by leakage Growth and decay of charge in a LCR circuit - Condition for the discharge to be oscillatory. ● Study of impedance of LCR circuits. ● Study of resonance in series LCR circuits.	6	CLO1, CLO5

Additional 30 hours for Practical

Learning Resources	
Text Books	1. Griffth D.J, *Introduction to Electrodynamics*, 4th Edition, Prentice Hall of India, 2012Murugesan R., *Properties of Matter and Acoustics*, Revised Edition, S.Chand and Company, 2005. 2. Murugeshan R., *Electricity and Magnetism*, 7th Edition, S. Chand and Company, 2008.
Ref. Books	1. Laud B.B, *Electromagnetics*. 2nd Edition, New Age International Publication, 2005. 2. Navina Wadhani, *Electricity and Magnetism*, Prentice Hall of India, 2012. 3. Tiwari A.K., *Electricity and Magnetism*, S.Chand and Company, 2007. 4. Halliday-Resnick and Walker, *Fundamentals of Physics – Electricity andMagnetism*, Wiley India Pvt Ltd , 2011. 5. Edward M Purcell, *Electricity and Magnetism*, Berkeley Physics Course, Volume 2, 2nd Edition, 2011.

Learning Assessment											
	Bloom's Level of Thinking	**Continuous Learning Assessment (40% weightage)**								**Final Examination (60% weightage)**	
		CLA – 1 (10%)		**CLA – 2 (10%)**		**CLA – 3 (10%)**		**CLA – 4 (10%)**			
		Theory	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**
Level 1	Remember	**50%**	**50%**	**50%**	**50%**	**30%**	**30%**	**30%**	**30%**	**30%**	-
	Understand										-
Level 2	Apply	**50%**	**50%**	**50%**	**50%**	**40%**	**40%**	**40%**	**40%**	**40%**	-
	Analyze										-
Level 3	Evaluate	-	-	-	-	**30%**	**30%**	**30%**	**30%**	**30%**	-
	Create	-	-	-	-						-
		100%		**100%**		**100%**		**100%**		**100%**	-

Course Designers		
Experts from Industry: Name, Designation with official mail id	Experts from Higher Education Institutions: Name, Designation with official mail id	Internal Experts: Name, Designation with official id
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Course	*PHY23CO22*	**Course**	*Mathematical Physics*	**Course Catego**	*C*	*Core*	L	T	P	C
							2	1	0	3

Code		Name		ry						
Pre-requisite	None	**Co-requisite**								

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	**Bloom's Learning (BL) Level**	**Program Learning Outcomes (PLO)**										
			PLO-1	**PLO-2**	**PLO-3**	**PLO-4**	**PLO-5**	**PLO-6**	**PLO-7**	**PLO-8**	**PLO-9**	**PLO-10**	**PLO-11**
			Domain Specific Knowledge	Critical Thinking and Problem Solving	Inter and Multi-disciplinary Skills	Lifelong learning	Research Aptitude	Creativity	Communication Skills	Innovation and Entrepreneurship	Vocational and Industry Exposure	Environmental awareness and sustainability	Ethics
CLO-1	Develop and comprehend the concepts of the curvilinear coordinate system.	2	H	H	H	H	H	H	H	-	-	-	H
CLO-2	Acquaint with the concept of vectors and its applications	3	H	H	H	M	M	M	H	-	-	-	M
CLO-3	Apply the concept of differential equations in solving problems	3	H	H	H	H	H	H	H	-		-	H
CLO-4	Develop and apply the concept of complex analysis in solving problems	3	H	H	H	H	H	H	H	-	-	-	H

CLO-5	Analyse and apply the concept of Fourier series and its applicatio ns	3	H	H	H				H	-	-	-	H

(Level of correlation: ***3-High, 2-Medium, 1-Low*** can be used)

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
Unit 1	**CURVILINEAR COORDINATE SYSTEM** Cartesian coordinate system, Polar coordinate system-line element-surface element-volume element, cylindrical polar coordinate- line element-surface element-volume element, spherical polar coordinate- line element-surface element-volume element, general coordinate transformation.	9	CLO1
Unit 2	**VECTOR CALCULUS** Vector differential calculus - gradient of a scalar field - directional derivative - divergence and curl of a vector field, line and surface integrals - Path Independence - Potential Functions and Conservative Fields - Green's theorem - Divergence theorem of Gauss - Stokes's theorem.	9	CLO2
Unit 3	**DIFFERENTIAL EQUATIONS** Linear Differential Equations - Differential Equations Reducible to Linear Form - Exact Differential Equations - Integrating Factors - Change of Variables - Solution of homogeneous linear differential equations of order n with constant coefficients - Solution of the non–homogeneous linear differential equations with constant coefficients by means of polynomial operators	9	CLO3
Unit 4	**COMPLEX ANALYSIS** Definition of Analytic Function – Cauchy Riemann equations – Properties of analytic functions – Determination of harmonic conjugate – Cauchy's integral theorem (without proof) – Cauchy's integral formulae and its applications – Taylor's and Laurent's expansions (statements only)	9	CLO4
Unit 5	**FOURIER SERIES** Introduction - Periodic functions: Properties - Even & Odd	9	CLO5

	functions – Properties - Special waveforms -square wave - Half wave Rectifier - Full wave Rectifier - Sawtooth wave - Fourier Series for functions of period 2π - Fourier Series for functions of period 2L - Fourier Series of a function with its periodic extension.		

Learning Resources	
Text Books	1. Satya Prakash, *Mathematical Physics*, Sultan Chand and Sons, Reprint 2016. 2. K.Ganesan, Sundarammal Kesavan, K.S.Ganapathy Subramanian &V.Srinivasan, *Advanced Calculus and Complex Analysis*, Revised Edition, 2013.
Ref. Books	1. Erwin Kreyszig, *Advanced Engineering Mathematics*, 10th Edition, Willey 2011. 2. Grewal B.S, *Higher Engg Maths*, Khanna Publications, 42nd Edition,2012. 3. Jain M C, *Vector Spaces and Matrices in Physics*, Narosa,2007. 4. Spiegel M R, Schaum's *Outline of Vector Analysis*, McGraw–Hill Education,2009.

Learning Assessment												
	Bloom's Level of Thinking	**Continuous Learning Assessment (40% weightage)**								**Final Examination (60% weightage)**	
		CLA – 1 (10%)		**CLA – 2 (10%)**		**CLA – 3 (10%)**		**CLA – 4 (10%)**			
		Theory	**Other Assessment**	**Theory**	**Other Assessment**	**Theory**	**Other Assessment**	**Theory**	**Other Assessment**	**Theory**	**Other Assessment**
Level 1	Remember	**50%**	**50%**	**50%**	**50%**	**30%**	**30%**	**30%**	**30%**	**30%**	**-**
	Understand										**-**
	Apply	**50%**	**50%**	**50%**	**50%**	**40%**	**40%**	**40%**	**40%**	**40%**	**-**

Learning Assessment											
	Bloom's Level of Thinking	**Continuous Learning Assessment (40% weightage)**								**Final Examination (60% weightage)**	
		CLA – 1 (10%)		**CLA – 2 (10%)**		**CLA – 3 (10%)**		**CLA – 4 (10%)**			
		Theory	**Other Assessment**	**Theory**	**Other Assessment**	**Theory**	**Other Assessment**	**Theory**	**Other Assessment**	**Theory**	**Other Assessment**
Level 1	Remember	**50%**	**50%**	**50%**	**50%**	**30%**	**30%**	**30%**	**30%**	**30%**	**-**
	Understand										**-**
Level 2	Analyze										**-**
Level 3	Evaluate	-	-	-	-	**30%**	**30%**	**30%**	**30%**	**30%**	**-**
	Create	-	-	-	-						**-**
		100%		**100%**		**100%**		**100%**		**100%**	**-**

Course Designers		
Experts from Industry: Name, Designation with official mail id	Experts from Higher Education Institutions: Name, Designation with official mail id	Internal Experts: Name, Designation with official id
Name: Dr. Jagdish Chandra Saraswatula *Designation : Director of Product Management, Brooks Automation, Germany* ***Email: Jagdish.saraswatula@gmail.com***	*ame: Prof. Prem Pal* *Designation: Professor, Indian Institute of Technology, Hyderabad.* ***Email: prem@iith.ac.in***	*Name: Dr. Nishal Rai* *Designation: Assistant professor, SRM University Sikkim* ***Email:nishalrai.g@srmus.edu.in***

Cour	*PHY23S*	**Cours**	*Solar Technology*	**Course**	*SEC*	*Skills Enhancement*	L	T	P	C

se Code	*E21*	e Name		Category		*Course*	1	0	4	3
Pre-requisite Nil				**Co - requisite**						

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	**Bloom's Learning (BL) Level**	**Program Learning Outcomes (PLO)**										
			PLO-1	**PLO-2**	**PLO-3**	**PLO-4**	**PLO-5**	**PLO-6**	**PLO-7**	**PLO-8**	**PLO-9**	**PLO-10**	**PLO-11**
			Domain Specific Knowledge	Critical Thinking and Problem Solving	Inter and Multi-disciplinary Skills	Lifelong learning	Research Aptitude	Creativity	Communication Skills	Innovation and Entrepreneurship	Vocational and Industry Exposure	Environmental awareness and sustainability	Ethics
CLO-1	Acquire knowledge about the fundamentals of solar energy technologies	2	H	H	H	H	H	H	H	-	-	-	H
CLO-2	Familiarize with solar thermal-based energy systems	3	H	H	H	H	H	H	H	-	-	-	M
CLO-3	Acquire basic concepts about solar cells	3	H	H	H	M	M	M	H	-		-	H
CLO-4	Comprehend about the basic principles and applications of Photovoltaic systems	3	H	H	H	H	H	H	H	-	-	-	H

CLO-5	Familiarize with solar passive architecture	3	H	H	H	M	M	H	H	-	-	-	H

(Level of correlation: ***3-High, 2-Medium, 1-Low*** can be used)

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
Unit 1	**SOLAR RADIATION AND COLLECTORS** Energy emitted by sun and energy that reaches the earth – Solar Collector Basics – Flat plate collector – Evacuated tubular collectors – Concentrator collectors – Tracking systems. ● To study the Solar Concentrator Training System ● To determine the Effects of Amount and Wavelength of Light on a Solar Cell.	3	CLO1
Unit 2	**SOLAR THERMAL TECHNOLOGIES** Solar heating and cooling system – Principle of working – Types – Design and operation – Thermal Energy storage – Types of thermal Energy Storage systems – Sensible Heat Storage – Liquids. Introduction to Solar Thermal Training System To study the Solar Panel Experiment (Remote Trigger). ● To study the working of solar fencing	3	CLO2
Unit 3	**SOLAR PV FUNDAMENTALS** Semiconductor – Properties – Energy levels – P–N junction– Equilibrium condition – Non equilibrium condition – Basic Silicon Solar cell – Efficiency limits – Variation of efficiency with band gap and temperature ● To study the working of solar photovoltaic systems.	3	CLO3
Unit 4	**SPV SYSTEM DESIGN AND APPLICATIONS** Photovoltaic cell – Photovoltaic module – PV array – Solar cell array design concepts – PV system design – Maximum power points tracking. ● To study the working of solar lighting. ● To study the working of solar pumping.	3	CLO4
Unit 5	**SOLAR PASSIVE ARCHITECTURE**	3	CLO5

	Passive heating concepts – Direct heat gain – Indirect heat gain – Thermal storage wall – Attached Greenhouse – Isolated gain and sunspaces – Passive cooling concepts – Evaporative cooling – Shading and ventilation – Radiative cooling. ● To study the working of solar cookers. ● To study the working of solar drying systems.		

Additional 60 hours for Practical

Learning Resources	
Text Books	1. Sukhatme S P, J K Nayak, *Solar Energy, Principle of Thermal Storage and Collection*, 3rd Edition, Tata McGraw Hill, 2008. 2. *Chetan Singh Solanki, Solar Photovoltaics, Fundamentals, Technologies and* Applications, PHI Learning Private Limited, 2011.
Ref. Books	1. Peter Würfel, *Physics of Solar Cells: From Basic Principles to Advanced Concepts*, Wiley–VCH, 2009.Jeffrey M. Gordon, Solar Energy: The State of the Art, Earthscan, 2013. 2. Garg H. P. and Prakash J., Solar *Energy Fundamentals and application*,TataMcGraw– Hill Publishing, 7th Reprint 2006. 3. Roger A. Messenger and Jerry Ventre, *Photovoltaic Systems Engineering* CRC Press, 2010. 4. Kalogirou S. A., *Solar Energy Engineering: Processes and Systems*, 2nd Edition, Academic Press, 2013.

Learning Assessment											
	Bloom's Level of Thinking	**Continuous Learning Assessment (100% weightage)**								**Final Examination (0% weightage)**	
		CLA – 1 (25%)		**CLA – 2 (25%)**		**CLA – 3 (25%)**		**CLA – 4 (25%)**			
		Theory	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**
Level 1	Remember	**50%**	**50%**	**50%**	**50%**	**30%**	**30%**	**30%**	**30%**	-	-
	Understand									-	-
Level 2	Apply	**50%**	**50%**	**50%**	**50%**	**40%**	**40%**	**40%**	**40%**	-	-
	Analyze									-	-
Level 3	Evaluate	-	-	-	-	**30%**	**30%**	**30%**	**30%**	-	-
	Create	-	-	-	-					-	-
		100%		**100%**		**100%**		**100%**		-	-

Course Designers		
Experts from Industry: Name, Designation with official mail id	Experts from Higher Education Institutions: Name, Designation with official mail id	Internal Experts: Name, Designation with official id
Name: Dr. Jagdish Chandra Saraswatula *Designation : Director of Product Management, Brooks Automation, Germany* ***Email: Jagdish.saraswatula@gmail.com***	*ame: Prof. Prem Pal* *Designation: Professor, Indian Institute of Technology, Hyderabad.* ***Email: prem@iith.ac.in***	*Name: Dr. Nishal Rai* *Designation: Assistant professor, SRM University Sikkim* ***Email:nishalrai.g@srmus.edu.in***

Cour	*PHY23*	**Cours**	*Mathematical Physics*	**Course**	*MI*	*Minor in Physics*	L	T	P	C

se Code	*MI21*	e Name		Category			2	1	0	3
Pre-requisite Nil				**Co-requisite**						

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	**Bloom's Learning (BL) Level**	**Program Learning Outcomes (PLO)**										
			PLO-1	**PLO-2**	**PLO-3**	**PLO-4**	**PLO-5**	**PLO-6**	**PLO-7**	**PLO-8**	**PLO-9**	**PLO-10**	**PLO-11**
			Domain Specific Knowledge	Critical Thinking and Problem Solving	Inter and Multi-disciplinary Skills	Lifelong learning	Research Aptitude	Creativity	Communication Skills	Innovation and Entrepreneurship	Vocational and Industry Exposure	Environmental awareness and sustainability	Ethics
CLO-1	Develop and comprehend the concepts of the curviline ar coordinat e system.	2	H	H	H	H	H	H	H	M	M	-	H
CLO-2	Acquaint with the concept of vectors and its applicatio ns	3	H	H	H	M	M	H	H	M	H	-	M
CLO-3	Apply the concept of differenti al equations in solving problems	3	H	H	H	H	H	M	H	H	M	-	H
CLO-4	Develop and apply the concept of complex analysis	3	H	H	H	H	H	H	H	M	M	-	H

	in solving problems												
CLO-5	Analyse and apply the concept of Fourier series and its applications	3	H	H	H	M	M	M	H	H	H	-	H

(Level of correlation: ***3-High, 2-Medium, 1-Low*** can be used)

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
Unit 1	**CURVILINEAR COORDINATE SYSTEM** Cartesian coordinate system, Polar coordinate system- line element-surface element-volume element, cylindrical polar coordinate- line element-surface element-volume element, spherical polar coordinate- line element-surface element-volume element.	9	CLO1
Unit 2	**VECTOR CALCULUS** Vector differential calculus - gradient of a scalar field - divergence and curl of a vector field, line and surface integrals - Path Independence.	9	CLO2
Unit 3	**DIFFERENTIAL EQUATIONS** Linear Differential Equations - Differential Equations Reducible to Linear Form - Exact Differential Equations - Integrating Factors - Change of Variables - Solution of homogeneous linear differential equations of order n with constant coefficients	9	CLO3
Unit 4	**COMPLEX ANALYSIS** Definition of Analytic Function – Cauchy Riemann equations – Properties of analytic functions – Determination of harmonic conjugate – Taylor's and	9	CLO4

	Laurent's expansions (statements only)		
Unit 5	**FOURIER SERIES** Introduction - Periodic functions: Properties - Even & Odd functions – Properties - Special waveforms -square wave - Sawtooth wave - Fourier Series for functions of period 2π - Fourier Series for functions of period 2L.	9	CLO5

Learning Resources	
Text Books	1. Satya Prakash, *Mathematical Physics*, Sultan Chand and Sons, Reprin 2016. 2. K.Ganesan, Sundarammal Kesavan, K.S.Ganapathy Subramaniar &V.Srinivasan, *Advanced Calculus and Complex Analysis*, Revised Edition, 2013.
Ref. Books	1. Erwin Kreyszig, *Advanced Engineering Mathematics*, 10th Edition, Willey 2011. 2. Grewal B.S, *Higher EnggMaths*, Khanna Publications, 42nd Edition,2012. 3. Jain M C, *Vector Spaces And Matrices In Physics*, Narosa,2007. 4. Spiegel M R, Schaum's *Outline of Vector Analysis*, McGraw–Hill Education,2009.

Learning Assessment											
	Bloom's Level of Thinking	**Continuous Learning Assessment (40% weightage)**								**Final Examination (60% weightage)**	
		CLA – 1 (10%)		**CLA – 2 (10%)**		**CLA – 3 (10%)**		**CLA – 4 (10%)**			
		Theory	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**
Level 1	Remember	**50%**	**50%**	**50%**	**50%**	**30%**	**30%**	**30%**	**30%**	**30%**	-
	Understand										-
Level 2	Apply	**50%**	**50%**	**50%**	**50%**	**40%**	**40%**	**40%**	**40%**	**40%**	-
	Analyze										-
Level 3	Evaluate	-	-	-	-	**30%**	**30%**	**30%**	**30%**	**30%**	-
	Create	-	-	-	-						-
		100%		**100%**		**100%**		**100%**		**100%**	-

Course Designers		
Experts from Industry: Name, Designation with official mail id	Experts from Higher Education Institutions: Name, Designation with official mail id	Internal Experts: Name, Designation with official id
Name: Dr. Jagdish Chandra Saraswatula *Designation : Director of Product Management, Brooks Automation, Germany* ***Email: Jagdish.saraswatula@gmail.com***	*ame: Prof. Prem Pal* *Designation: Professor, Indian Institute of Technology, Hyderabad.* ***Email: prem@iith.ac.in***	*Name: Dr. Nishal Rai* *Designation: Assistant professor, SRM University Sikkim* ***Email:nishalrai.g@srmus.edu.in***

Course Code	*PHY23MD21*	**Course Name**	*Physics of Everyday Life*	**Course Category**	*MD*	*Multidisciplinary*	L	T	P	C
							2	0	2	3

Pre-requisite Nil		**Co-requisite**					

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	**Bloom's Learning (BL) Level**	**Program Learning Outcomes (PLO)**										
			PLO-1	**PLO-2**	**PLO-3**	**PLO-4**	**PLO-5**	**PLO-6**	**PLO-7**	**PLO-8**	**PLO-9**	**PLO-10**	**PLO-11**
			Domain Specific Knowledge	Critical Thinking and Problem Solving	Inter and Multi-disciplinary Skills	Lifelong learning	Research Aptitude	Creativity	Communication Skills	Innovation and Entrepreneurship	Vocational and Industry Exposure	Environmental awareness and sustainability	Ethics
CLO-1	Comprehend the general concepts of Laws of Physics	2	H	H	H	H	H	H	H	-	-	-	H
CLO-2	Identify and explain the different kinds of motion.	3	H	H	H				H	-	-	-	M
CLO-3	Develop the basic concept of Heat and Thermodynamics.	3	H	H	H				H	-		-	H
CLO-4	Comprehend and analyze the significance of Electrodynamics.	3	H	H	H	H	H	H	H	-	-	-	H
CLO-5	Apply the	3	H	H	H				H	-	-	-	H

	Physics concepts in day-to-day life.												

(Level of correlation: ***3-High, 2-Medium, 1-Low*** can be used)

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
Unit 1	**THE LAWS OF MOTION** Newton's Law of motion, Force, Energy, Falling Balls Ramps, Collisions, and bumper cars. ● Determination of Young's modulus of the material of the beam – Uniform Bending (Pin and Microscope). ● Determination of Young's modulus of the material of the beam – Non-uniform bending (Pin and Microscope).	6	CLO1
Unit 2	**MECHANICAL OBJECTS** Spring Scales, Ball Sports: Bouncing, Uniform Circular motion, Angular Momentum, roller coasters, seesaws Bicycles, Rockets and Space Travel. ● Determination of acceleration due to gravity– Compound bar pendulum.	6	CLO2
Unit 3	**HEAT** Wood stoves, Water, Steam, and Ice, insulation Thermodynamics – air conditioners and automobiles ● Determination of Thermal conductivity of a bad conductor using Lee's disc Method. ● Determination of Specific Heat Capacity of the liquid using Newton's Law of Cooling.	6	CLO3
Unit 4	**ELECTRICITY** Lightning rods, air cleaners and photocopies, Electrical Currents, Magnetism and electrodynamics – tape records, electric motors, hybrid car Magnet lab	6	CLO4

	Electronics – audio amplifiers, computers. ● Study of resonance in series LCR circuits. ● Determination of dielectric constant for a given material.		
Unit 5	**ELECTROMAGNETIC WAVES** Radio and television, microwave ovens Light – sunlight fluorescent light, lasers, Optic – optical recording, CD DVD Player, Modern Physics- Nuclear Reactors. ● Determination of wavelengths of mercury spectrum using a prism in minimum deviation. ● Determination of numerical aperture and acceptance angle of the optical fiber using a laser. ● Determination of the dispersive power of a prism using a spectrometer.	6	CLO5

Additional 30 hours for Practical

Learning Resources	
Text Books	1. Physics in Everyday Life, Vedang Sati, Shashwat Goswami, CreateSpace Independent Publishing Platform, 2016
Ref. Books	1. How Things Work: The Physics of Everyday Life, 4th Edition, Louis A. Bloomfield,Wiley; 4th edition (9 January 2009)

Learning Assessment											
	Bloom's Level of Thinking	**Continuous Learning Assessment (100% weightage)**								**Final Examination (0% weightage)**	
		CLA – 1 (10%)		**CLA – 2 (10%)**		**CLA – 3 (10%)**		**CLA – 4 (10%)**			
		Theory	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**
Level 1	Remember	**50%**	**50%**	**50%**	**50%**	**30%**	**30%**	**30%**	**30%**	-	-
	Understand										-
Level 2	Apply	**50%**	**50%**	**50%**	**50%**	**40%**	**40%**	**40%**	**40%**	-	-
	Analyze										-
Level 3	Evaluate	-	-	-	-	**30%**	**30%**	**30%**	**30%**	-	-
	Create	-	-	-	-						-
		100%		**100%**		**100%**		**100%**		-	-

Course Designers		
Experts from Industry: Name, Designation with official mail id	Experts from Higher Education Institutions: Name, Designation with official mail id	Internal Experts: Name, Designation with official id
Name: Dr. Jagdish Chandra Saraswatula *Designation : Director of Product Management, Brooks Automation, Germany* ***Email: Jagdish.saraswatula@gmail.com***	*ame: Prof. Prem Pal* *Designation: Professor, Indian Institute of Technology, Hyderabad.* ***Email: prem@iith.ac.in***	*Name: Dr. Nishal Rai* *Designation: Assistant professor, SRM University Sikkim* ***Email:nishalrai.g@srmus.edu.in***

Course Code	*PHY23MD31*	Course Name	*Basics And Importance Of Quantum Technology*	Course Category	*MD*	*Multidisciplinary*	L	T	P	C
							2	0	2	3
Pre-requisite				**Co-requisite**						

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	**Bloom's Learning (BL) Level**	**Program Learning Outcomes (PLO)**										
			PLO-1	**PLO-2**	**PLO-3**	**PLO-4**	**PLO-5**	**PLO-6**	**PLO-7**	**PLO-8**	**PLO-9**	**PLO-10**	**PLO-11**
			Domain Specific Knowledge	Critical Thinking and Problem Solving	Inter and Multi disciplinary Skills	Lifelong learning	Research Aptitude	Creativity	Communication Skills	Innovation and Entrepreneurship	Vocational and Industry Exposure	Environmental awareness and sustainability	Ethics
CLO-1	Comprehend the basic concept of Quantum mechanics.	3	H	H	H	H	H	-	-	M	M	-	H
CLO-2	Acquire knowledge about the quantum oscillators.	3	H	H	H	H	H	-	-	M	M	-	H
CLO-3	Acquire knowledge on data transfer schemes and applications	3	H	H	H	H	H	-	-	M	M	-	H
CLO-4	Comprehend the concept behind quantum	4	H	H	H	-	H	M	-	-	M	-	H

	cryptography.												
CLO-5	Apply the knowledge in coding different operations using quantum computers (IBM).	4	H	H	H	H	H	-	-	M	M	-	H

(Level of correlation: ***3-High, 2-Medium, 1-Low*** can be used)

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
Unit 1	**ELEMENTARY QUANTUM MECHANICS** Black body radiation - De Broglie hypothesis - Uncertainty Principle - two-slit experiment -Schrodinger wave equation - linear superposition principle - superposition of states quantum states - Measurements. ● Photo-electric effect: photocurrent versus intensity and wavelength of light	9	CLO1, CLO2
Unit 2	**UNIT II QUANTUM CORRELATIONS** General qubit states - Spin states - Bell inequalities quantum entanglement - No cloning theorem - quantum teleportation ● Photo-electric effect: Maximum energy of photo-electrons versus frequency of light	9	CLO1, CLO2
Unit 3	**UNIT III QUANTUM GATES AND ALGORITHMS** Classical and quantum gates - quantum circuits - Deutsch algorithm - Grover search algorithm - Shor's algorithm factoring.	9	CLO3

	• Determination of Planck's constant using photovoltaic cell.		
Unit 4	**UNIT IV QUANTUM CRYPTOGRAPHY** Quantum key distribution - Advantages of quantum cryptography - Implementation in practice - Current and future prospects. • Determination of Planck's constant using light-emitting diodes.	9	CLO4, CLO1
Unit 5	**UNIT V PROGRAMMING A QUANTUM COMPUTER** The IBMQ, coding a quantum computer using a simulator to carry out basic quantum measurement and state analysis. • Study of spectral lines using spectrometers for different sources. • Basic operations using Qiskit	9	, CLO5, CLO1

Learning Resources	
Text Books	1. Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education. 2. Quantum technology (Frontiers of science), Gerard J. Milburn 3. Quantum Computation and Quantum Information: 10th Anniversary Edition. 4. Quantum Computation and Quantum Information: 10th Anniversary Edition
Ref. Books	1. Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGraw Hill 2. Quantum Mechanics: Theory & Applications, A.K.Ghatak & S.Lokanathan 2004, Macmillan 3. Modern Physics, J.R. Taylor, C.D. Zafiratos, M.A. Dubson, 2004, PH Learning 4. https://www.ibm.com/quantum/qiskit-runtime

Learning Assessment											
	Bloom's Level of Thinking	**Continuous Learning Assessment (100% weightage)**								**Final Examination (0% weightage)**	
		CLA – 1 (10%)		**CLA – 2 (10%)**		**CLA – 3 (10%)**		**CLA – 4 (10%)**			
		Theory	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**
Level 1	Remember	**50%**	**50%**	**50%**	**50%**	**30%**	**30%**	**30%**	**30%**	-	-
	Understand									-	-
Level 2	Apply	**50%**	**50%**	**50%**	**50%**	**40%**	**40%**	**40%**	**40%**	-	-
	Analyze									-	-
Level 3	Evaluate	-	-	-	-	**30%**	**30%**	**30%**	**30%**	-	-
	Create	-	-	-	-					-	-
		100%		**100%**		**100%**		**100%**		-	-

Course Designers		
Experts from Industry: Name, Designation with official mail id	Experts from Higher Education Institutions: Name, Designation with official mail id	Internal Experts: Name, Designation with official id
Name: Dr. Jagdish Chandra Saraswatula *Designation : Director of Product Management, Brooks Automation, Germany* ***Email: Jagdish.saraswatula@gmail.com***	*Name: Prof. Prem Pal* *Designation: Professor, Indian Institute of Technology, Hyderabad.* *Email: prem@iith.ac.in*	*Name: Dr. Nishal Rai* *Designation: Assistant professor, SRM University Sikkim* ***Email:nishalrai.g@srmus.edu.in***

Semester III

Course Code	*PHY23CO31*	Course Name	*Thermal Physics*	Course Category	*C*	*Core*	L	T	P	C
							4	0	2	4

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO-1	PLO-2	PLO-3	PLO-4	PLO-5	PLO-6	PLO-7	PLO-8	PLO-9	PLO-10	PLO-11
			Domain Specific Knowledge	Critical Thinking and Problem Solving	Inter and Multi-disciplinary Skills	Lifelong learning	Research Aptitude	Creativity	Communication Skills	Innovation and Entrepreneurship	Vocational and Industry Exposure	Environmental awareness and sustainability	Ethics
CLO-1	Comprehend the fundamentals of heat.	4	H	H	H	H	H	-	-	M	M	-	H
CLO-2	Acquaint with the concepts involved in the transmission of heat.	4	H	H	H	H	H	-	-	M	M	-	H
CLO-3	Comprehend the basic principle and laws of thermodynamics and their applications	5	H	H	H	H	H	-	-	M	M	-	H
CLO-4	Acquaint with the concepts	5	H	H	H	-	H	M	-	-	M	-	H

	of entropy.												
CLO-5	Analyze Maxwell's thermodynamical relations and their applications	5	H	H	H	H	H	-	-	M	M	-	H

(Level of correlation: ***3-High, 2-Medium, 1-Low*** can be used)

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
Unit 1	**Introduction of Heat** Basic Definitions – Newton's law of cooling – Specific heat of a liquid callender and Barne's continuous flow method – Two specific heats of a gas – Specific heat of a gas by Jolly's differential steam calorimeter – Regnault's method – Dulong and Petit's law –variation of specific heat and atomic heat with temperature – Transference of heat. ● Determination of Thermal conductivity of a bad conductor using Lee's disc method. ● Determination of Specific Heat Capacity of the liquid using Newton's Law of Cooling	12	CLO1, CLO2
Unit 2	**Transmission of Heat** Conduction – Coefficient of the thermal conductivity – Rectilinear flow of heat along a metal bar – Methods of radial flow of heat – Determination of thermal conductivity of rubber and bad conductor – Lee's disc method to find thermal conductivity of bad conductor. Conduction – Radiation – Black body – Wien's Law – Raleigh Law and its significance –Jean's Law – Stefan's Law – Experimental Determination of Stefan's constant – Mathematical derivation of Stefan's Law. ● Calculate the Temperature coefficient of resistance of the given coil by Carey Foster Bridge.	12	CLO1, CLO2
Unit 3	**Kinetic Theory of Gasses**	12	CLO2,CLO3

	Maxwell's law of distribution of molecular velocities – Equilibrium speed distribution of velocities – Mean free path of gaseous molecules – Transport phenomena – Diffusion of gases – Vander walls equation of state – Determination of Vander walls constant – Comparison of van der Waals equation with Andrews experiment – Relation between Vander Wall's constant and critical constants. ● Determination of thermal conductivity of good conductors by Searle's method.		
Unit 4	**Laws of Thermodynamics** First law of thermodynamics – Isothermal and Adiabatic process – Gas equation during an adiabatic process – Work done an adiabatic expansion of gas – Equation of an adiabatic curve – Isothermal processes – Determination of g by Clement and Desorme's method – Second law of thermodynamics – Concept of Carnot's engine– Working efficiency of Carnot's engine – Carnot's refrigerator – Carnot's Theorem and its significance. ● Determination of the Specific Heat Capacity of the liquid using Joule's calorimeter.	12	CLO3, CLO5
Unit 5	**Concepts of Entropy** Third law of thermodynamics – Concept of Entropy – Temperature entropy diagram – entropy of perfect gas – Entropy Change in entropy in a reversible process and irreversible process – temperature entropy diagram – Entropy of a perfect gas – increase of entropy in any irreversible process – Thermo dynamics functions – Maxwell's thermodynamics relations and applications – Joule Kelvin effect theory– Claussius and Clapeyron equation – Specific Heat Relation. ● Determination of specific heat capacity of a liquid by continuous flow (Callender and Barnes) method	12	CLO4, CLO5

Additional 30 hours for Practical

Learning Resources	
Text Books	1. Brijlal, N. Subrahmanyam and P. S. Hemne,*Heat,Thermodynamics andStatistical Physics*, Revised Edition, S. Chand and Company, 2010. 2. Richard H Dittman and Zemansky MW, *Heat and Thermodynamics*, 3rd Special Edition, McGraw Hill, 2008

Ref. Books	1. Michael J. Moran, Howard N. Shapiro, Daisie D. Boettner and Margaret Bailey, *Fundamentals of Engineering Thermodynamics*, John Wiley and Sons, 2011. 2. D.S. Mathur, *Heat and Thermodynamics*, S. Chand and Company, 2006. 3. Kittel C and Kroemer H, *Thermal Physics*, W. H. Free man, New York, 1980. 4. Stephen Blundell and Katherine M. Blundell, *Concepts in Thermal Physics*, Oxford University Press, 2006.

Learning Assessment											
	Bloom's Level of Thinking	**Continuous Learning Assessment (100% weightage)**								**Final Examination (60% weightage)**	
		CLA – 1 (10%)		**CLA – 2 (10%)**		**CLA – 3 (10%)**		**CLA – 4 (10%)**			
		Theory	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**
Level 1	Remember	**50%**	**50%**	**50%**	**50%**	**30%**	**30%**	**30%**	**30%**	**30%**	-
	Understand										-
Level 2	Apply	**50%**	**50%**	**50%**	**50%**	**40%**	**40%**	**40%**	**40%**	**40%**	-
	Analyze										-
Level 3	Evaluate	-	-	-	-	**30%**	**30%**	**30%**	**30%**	**30%**	-
	Create	-	-	-	-						-
		100%		**100%**		**100%**		**100%**		**100%**	-

Course Designers		
Experts from Industry: Name, Designation with official mail id	Experts from Higher Education Institutions: Name, Designation with official mail id	Internal Experts: Name, Designation with official id
Name: Dr. Jagdish Chandra Saraswatula *Designation : Director of Product Management, Brooks Automation,*	*ame: Prof. Prem Pal* *Designation: Professor, Indian Institute of Technology, Hyderabad.* ***Email: prem@iith.ac.in***	*Name: Dr. Nishal Rai* *Designation: Assistant professor,*

Germany ***Email: Jagdish.saraswatula@gmail.com***		*SRM University Sikkim* ***Email:nishalrai.g@srmus.edu.in***

Course Code	*PHY23CO32*	**Course Name**	*Special Theory Of Relativity*	**Course Category**	*C*	*Core*	L	T	P	C
							3	1	0	4
Pre-requisite			None							

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	**Bloom's Learning (BL) Level**	**Program Learning Outcomes (PLO)**										
			PLO-1	**PLO-2**	**PLO-3**	**PLO-4**	**PLO-5**	**PLO-6**	**PLO-7**	**PLO-8**	**PLO-9**	**PLO-10**	**PLO-11**
			Domain Specific Knowledge	Critical Thinking and Problem Solving	Inter and Multi-disciplinary Skills	Lifelong learning	Research Aptitude	Creativity	Communication Skills	Innovation and Entrepreneurship	Vocational and Industry Exposure	Environmental awareness and sustainability	Ethics
CLO-1	Gain knowledge regarding the concept of Lorentz Transformation	2	H	H	H	H	H	-	-	M	M	-	H
CLO-2	Acquaint with the concepts involved in the relativistic effects.	3	H	H	H	H	H	-	-	M	M	-	H
CLO-3	Comprehend the	3	H	H	H								

	concept of metric and metric space.					H	H	-	-	M	M	-	H
CLO-4	Acquaint with the concepts of relativistic mechanics.	3	H	H	H	-	H	M	-	-	M	-	H
CLO-5	Apply the concept of relativity in particle collision.	3	H	H	H	H	H	-	-	M	M	-	H

(Level of correlation: ***3-High, 2-Medium, 1-Low*** can be used)

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
Unit 1	**INERTIAL FRAMES AND THE LORENTZ TRANSFORMATION** Concepts of Frames of reference, Inertial frames, Galilean Transformation, Maxwell's equations, Non-invariance of Maxwell's equations under Galilean transformation, Ether and Experiments for its detection, Micehlson-Morley experiment, Einstein's relativity postulate and the derivation of the Lorentz transformation. The properties and graphic representation of the Lorentz transformation.	12	CLO1, CLO2
Unit 2	**GEOMETRY OF RELATIVITY AND RELATIVISTIC EFFECTS** Relativity of simultaneity, Time dilation, Length contraction Clock synchronization, Relativistic effects and Paradoxes in special relativity. Einstein's velocity addition rule, Relativistic Doppler effect, and Concept of Doppler Redshift.	12	CLO2
Unit 3	**STRUCTURE OF SPACE-TIME** Four Vectors, Concept of Metric and Metric Space, Lorentz transformation matrix, Metric Tensor, Line element,	12	CLO1, CLO3, CLO4

	Invariance of line element under Lorentz transformation, Invariant interval: space like, timelike, nullike, Space-time diagrams, Minkowski space, Light-cone, Notion of causality		
Unit 4	**RELATIVISTIC MECHANICS** Proper time and Proper Velocity, Lorentz transformation of velocity, Relativistic Energy and momentum, Relativistic mass, Mass-energy equivalence, Energy-momentum conservation, Invariant quantities, Lorentz transformation of acceleration, Four acceleration and Force, Proper acceleration, Minkowski force.	12	CLO1, CLO3, CLO4
Unit 5	**APPLICATION OF SPECIAL RELATIVITY TO PARTICLE COLLISIONS** Conservation in special relativity, Energy-momentum relation for massless particles, Properties of the photon, Collision problems with massive and massless particles, Compton scattering, Pair production and pair annihilation.	12	CLO3, CLO5

Learning Assessment											
	Bloom's Level of Thinking	**Continuous Learning Assessment (100% weightage)**								**Final Examination (60% weightage)**	
		CLA – 1 (10%)		**CLA – 2 (10%)**		**CLA – 3 (10%)**		**CLA – 4 (10%)**			
		Theory	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**
Level 1	Remember	**50%**	**50%**	**50%**	**50%**	**30%**	**30%**	**30%**	**30%**	**30%**	-
	Understand										-
Level 2	Apply	**50%**	**50%**	**50%**	**50%**	**40%**	**40%**	**40%**	**40%**	**40%**	-
	Analyze										-
Level 3	Evaluate	-	-	-	-	**30%**	**30%**	**30%**	**30%**	**30%**	-
	Create	-	-	-	-						-
		100%		**100%**		**100%**		**100%**		**100%**	-

Learning Resources	
Text Books	1. Robert Resnick, Introduction to Special Relativity, New York, Wiley 1968 2. A. P French, Special Relativity, MIT Introductory Physics Series, New York, Norton 1968 3. H. Goldstein, Classical Mechanics, 3rd Ed, Addison-Wesley, 2002
Ref. Books	1. David J. Griffiths, Introduction to Electrodynamics, 4th Ed, Pearson, 2013 2. J. D. Jackson, Classical Electrodynamics, 3rd Ed, New York, Wiley, 1999

Course Designers		
Experts from Industry: Name, Designation with official mail id	Experts from Higher Education Institutions: Name, Designation with official mail id	Internal Experts: Name, Designation with official id
Name: Dr. Jagdish Chandra Saraswatula *Designation : Director of Product Management, Brooks Automation, Germany* ***Email: Jagdish.saraswatula@gmail.com***	*Name: Prof. Prem Pal* *Designation: Professor, Indian Institute of Technology, Hyderabad.* ***Email: prem@iith.ac.in***	*Name: Dr. Nishal Rai* *Designation: Assistant professor, SRM University Sikkim* ***Email:nishalrai.g@srmus.edu.in***

Course Code	*PHY23SE31*	**Course Name**	*Laboratory Theory and Practical*	**Course Category**	*SEC*	*Skills Enhancement course*	L	T	P	C
							1	0	4	3
Pre-requisite			None							

Course Learning	*At the end of this*	**Bloom's Learni**	**Program Learning Outcomes (PLO)**										
			PLO-1	**PLO-2**	**PLO-3**	**PLO-4**	**PLO-5**	**PLO-6**	**PLO-7**	**PLO-8**	**PLO-9**	**PLO-10**	**PLO-11**

Outcomes (CLO)	*course, learners will be able to:*	**ng (BL) Level**	Domain Specific Knowledge	Critical Thinking and Problem Solving	Inter and Multi-disciplinary Skills	Lifelong learning	Research Aptitude	Creativity	Communication Skills	Innovation and Entrepreneurship	Vocational and Industry Exposure	Environmental awareness and sustainability	Ethics
CLO-1	Comprehend the basic concept of error and error calculation	5	H	H	H	H	H	-	-	M	M	-	H
CLO-2	Acquire knowledge about the measurements using electrical instruments.	5	H	H	H	H	H	-	-	M	M	-	H
CLO-3	Acquaint with the visual representation of different digital signals.	5	H	H	H	H	H	-	-	M	M	-	H
CLO-4	Comprehend the concept of signal generators.	5	H	H	H	-	H	M	-	-	M	-	H
CLO-5	Apply the digital concepts in handling different measuring instruments.	5	H	H	H	H	H	-	-	M	M	-	H

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
Unit 1	**MEASUREMENTS AND ERRORS** Instruments accuracy, precision, sensitivity, resolution range etc. Errors in measurements and loading effects. Principles of measurement. ● Measurements and error calculation of Vernier Caliper, Screw Gauge, Traveling microscope and other measuring instruments. ● Determination of Young's modulus of the material of the beam – Non uniform bending (Pin and Microscope).	15	CLO1, CLO3, CLO4, CLO5
Unit 2	**TRANSPORT MEASUREMENT FOR DC AND AC** Advantage over conventional multimeter for voltage measurement. Principles of voltage measurement (block diagram only). AC millivoltmeter- Type and block diagram AC millivoltmeter ● Determination of acceleration due to gravity– Compound bar pendulum. ● Study of resonance in series LCR circuits.	15	CLO3, CLO4, CLO5
Unit 3	**VISUALISATION AND MEASUREMENT IN AC AND DC SIGNAL** Block diagram of basic CRO. Construction of CRT, Electron gun, electrostatic focusing and acceleration (Explanation only– no mathematical treatment). Use of CRO for the measurement of voltage, frequency and time period. Digital storage Oscilloscope: Block diagram and principle of working. ● Determination of Thermal conductivity of a bad conductor using Lee's disc Method. ● Determination of Specific Heat Capacity of the liquid using Newton's Law of Cooling.	15	CLO3, CLO4, CLO5
Unit 4	**SIGNAL GENERATORS** Block diagram, explanation of signal generators, pulse generator and function generator. ● Determination of dielectric constant for a given material. ● Determination of wavelengths of mercury spectrum using a prism in minimum deviation.	15	CLO3, CLO4, CLO5

Unit 5	**HANDLING OF DIGITAL METER/MULTIMETER** Principle and working of digital meters and multimeters. Comparison of analog & digital instruments. Characteristics of a digital meter. • Determination of numerical aperture and acceptance angle of the optical fiber using laser. • Determination of the dispersive power of a prism using a spectrometer.	15	CLO3, CLO4, CLO5

Learning Resources	
Text Books	1. Sudhakar A and Shyammohan S Palli, Circuits and Network Analysis and Synthesis, 4th Edition, Tata McGraw Hill, 2010. 2. Metha V.K., Mehta R., Principles of Electronics, S. Chand and Company Ltd., 2008.
Ref. Books	1. Jacob Millman, Christos C Halkias, Satyabrata Jit, Electron Devices and Circuits, Tata McGraw Hill, 2010. 2. Millman and Halkias ,Electronics Devices and Circuits, Tata Mc Graw Hill,2008. 3. William H.Hyte, Jr, J.E.Kemmerly and Steven M.Durban, Engineering CircuitAnalysis, 7 th Edition, McGraw Hill, 2010. 4. Robert L. Boylestad and Louis Nashelsky, Electronic Devices and CircuitTheory, Pearson Education, 9 th Edition, 2009.

Learning Assessment											
	Bloom's Level of Thinking	**Continuous Learning Assessment (100% weightage)**								**Final Examination (0% weightage)**	
		CLA – 1 (10%)		**CLA – 2 (10%)**		**CLA – 3 (10%)**		**CLA – 4 (10%)**			
		Theory	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**
Level 1	Remember	**50%**	**50%**	**50%**	**50%**	**30%**	**30%**	**30%**	**30%**	**-**	**-**
	Understand									-	**-**
	Apply	**50%**	**50%**	**50%**	**50%**	**40%**	**40%**	**40%**	**40%**	**-**	**-**

Learning Assessment											
	Bloom's Level of Thinking	**Continuous Learning Assessment (100% weightage)**								**Final Examination (0% weightage)**	
		CLA – 1 (10%)		**CLA – 2 (10%)**		**CLA – 3 (10%)**		**CLA – 4 (10%)**			
		Theory	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**
Level 1	Remember	**50%**	**50%**	**50%**	**50%**	**30%**	**30%**	**30%**	**30%**	**-**	**-**
	Understand									-	**-**
Level 2	Analyze									-	**-**
Level 3	Evaluate	-	-	-	-	**30%**	**30%**	**30%**	**30%**	**-**	**-**
	Create	-	-	-	-					-	**-**
		100%		**100%**		**100%**		**100%**		**100%**	**-**

Course Designers		
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Course Code	PHY23MI31	Course Name	Waves and Oscillations	Course Category	MI	Minor	L	T	P	C
							3	0	0	3
Pre-requisite			NIL							

Course Learning Outcomes (CLO)	At the end of this course, learners will be able to:	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO-1	PLO-2	PLO-3	PLO-4	PLO-5	PLO-6	PLO-7	PLO-8	PLO-9	PLO-10	PLO-11
			Domain Specific Knowledge	Critical Thinking and Problem Solving	Inter and Multi-disciplinary Skills	Lifelong learning	Research Aptitude	Creativity	Communication Skills	Innovation and Entrepreneurship	Vocational and Industry Exposure	Environmental awareness and sustainability	Ethics
CLO-1	Define, classify and analyse different concepts of Simple Harmonic oscillation.	4	H	H	H	H	H	-	-	M	M	-	H
CLO-2	Develop the concept of damped and forced oscillation.	4	H	H	H	H	H	-	-	M	M	-	H
CLO-3	Comprehend the basic principles and idea of complex vibration.	5	H	H	H	H	H	-	-	M	M	-	H
CLO-4	Develop the concept of the vibration of strings	5	H	H	H	-	H	M	-	-	M	-	H

CLO-5	Apply the concepts and theories in ultrasonics.	5	H	H	H	H	H	-	-	M	M	-	H

(Level of correlation: ***3-High, 2-Medium, 1-Low*** can be used)

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
Unit 1	**SIMPLE HARMONIC OSCILLATIONS** Simple harmonic oscillator and solution of the differential equation-Physical characteristics of SHM, torsion pendulum measurements of rigidity modulus, compound pendulum measurement of 'g', combination of two mutually perpendicular simple harmonic vibrations of the same frequency and different frequencies. Lissajous figures. ● Determination of rigidity modulus using Torsional Pendulum – Without masses.	9	CLO1, CLO2
Unit 2	**DAMPED AND FORCED OSCILLATIONS** Damped harmonic oscillator, solution of the differential equation of damped oscillator. Energy considerations comparison with un-damped harmonic oscillator, logarithmic decrement, relaxation time, quality factor, differential equation of forced oscillator and its solution, amplitude resonance and velocity resonance. ● Determination of rigidity modulus using static torsion method.	9	CLO1, CLO2
Unit 3	**COMPLEX VIBRATIONS** Fourier theorem and evaluation of the Fourier coefficients analysis of periodic wave functions-square wave, triangular wave, sawtooth wave ● Determination of frequency using a Sonometer.	9	CLO1, CLO2
Unit 4	**VIBRATING STRINGS** Transverse wave propagation along a stretched string, general solution of the wave equation and its significance, modes of vibration of stretched string clamped at ends, overtones	9	CLO3, CLO5

	energy transport and transverse impedance. Vibrations of bars : Longitudinal vibrations in bars-wave equation and its general solution. Special cases i) bar fixed at both ends ii) bar fixed at the mid point iii) bar free at both ends iv) bar fixed at one end. Tuning fork. ● Determination of acceleration due to gravity– Compound bar pendulum.		
Unit 5	**ULTRASONICS** Ultrasonics, properties of ultrasonic waves, production of ultrasonics by piezoelectric and magnetostriction methods detection of ultrasonics, determination of wavelength of ultrasonic waves. Applications of ultrasonic waves. ● Determination of Magnetic moment and Ratio of magnetic moments by Searle's vibration magnetometer method.	9	CLO4, CLO5

Learning Resources	
Text Books	1. Mechanics of Particles, Waves and Oscillations. Anwar Kamal, New Age International. 2. College Physics - I. T. Bhimasankaram and G. Prasad. Himalaya Publishing House.
Ref. Books	1. Fundamentals of Physics. Halliday/Resnick/Walker , Wiley India Edition 2007. 2. Introduction to Physics for Scientists and Engineers. F.J. Ruche. McGraw Hill. 3. Waves and Oscillations. N. Subramaniyam and Brijlal Vikas Publishing House Private Limited. 4. Unified Physics Vol.I Mechanics, Waves and Oscillations – Jai Prakash Nath &co. 5. Science and Technology of Ultrasonics- Bladevraj, Narosa, New Delhi, 2004 6. Waves and Oscillations. S. Badami, V. Balasubramanian and K. Rama Reddy Orient Longman.

Learning Assessment											
	Bloom's Level of Thinking	**Continuous Learning Assessment (100% weightage)**								**Final Examination (60% weightage)**	
		CLA – 1 (10%)		**CLA – 2 (10%)**		**CLA – 3 (10%)**		**CLA – 4 (10%)**			
		Theory	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**
Level 1	Remember	**50%**	**50%**	**50%**	**50%**	**30%**	**30%**	**30%**	**30%**	**30%**	-
	Understand										-
Level 2	Apply	**50%**	**50%**	**50%**	**50%**	**40%**	**40%**	**40%**	**40%**	**40%**	-
	Analyze										-
Level 3	Evaluate	-	-	-	-	**30%**	**30%**	**30%**	**30%**	**30%**	-
	Create	-	-	-	-						-
		100%		**100%**		**100%**		**100%**		**100%**	-

Course Designers		
Experts from Industry: Name, Designation with official mail id	Experts from Higher Education Institutions: Name, Designation with official mail id	Internal Experts: Name, Designation with official id
Name: Dr. Jagdish Chandra Saraswatula *Designation : Director of Product Management, Brooks Automation, Germany* ***Email: Jagdish.saraswatula@gmail.com***	*ame: Prof. Prem Pal* *Designation: Professor, Indian Institute of Technology, Hyderabad.* ***Email: prem@iith.ac.in***	*Name: Dr. Nishal Rai* *Designation: Assistant professor, SRM University Sikkim* ***Email:nishalrai.g@srmus.edu.in***

Semester IV

Course Code	*PHY23CO41*	Course Name	*Quantum Mechanics*	Course Category	*C*	*Core*	L	T	P	C
							3	1	0	4
Pre-requisite			**Nil**							

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	**Bloom's Learning (BL) Level**	**Program Learning Outcomes (PLO)**										
			PLO-1	**PLO-2**	**PLO-3**	**PLO-4**	**PLO-5**	**PLO-6**	**PLO-7**	**PLO-8**	**PLO-9**	**PLO-10**	**PLO-11**
			Domain Specific Knowledge	Critical Thinking and Problem Solving	Inter and Multi-disciplinary Skills	Lifelong learning	Research Aptitude	Creativity	Communication Skills	Innovation and Entrepreneurship	Vocational and Industry Exposure	Environmental awareness and sustainability	Ethics
CLO-1	Analyze the origin and historical development of quantum mechanics: wave-practice duality and Uncertainly principle	3	H	H	M	H	H	-	-	M	M	-	H
CLO-2	Comprehend the postulates and developing mathematical foundation of	3	H	H	H	H	H	-	-	M	M	-	H

	quantum mechanics												
CLO-3	Apply Schrodinger wave equation to basic quantum problems	4	H	M	H	H	H	-	-	M	M	-	H
CLO-4	Comprehend advanced mathematical techniques in regard to the quantum framework: solving harmonic oscillator problems	5	H	H	H	-	H	M	-	-	M	-	H
CLO-5	Apply quantum mechanics in solving the hydrogen atom problem.	5	H	M	H	H	H	-	-	M	M	-	H

(Level of correlation: ***3-High, 2-Medium, 1-Low*** can be used)

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
Unit 1	**WAVE NATURE OF MATTER** Inadequacy of classical mechanics – Black body radiation - Quantum theory – Photoelectric effect –Compton effect - Wave-Particle Duality – Expressions for de–Broglie wavelength – Fourier transformation- localization - position space and k-space Concept of wave packet - phase and group velocity - Uncertainty Principle - Young's double sli	12	CLO1

	experiment - Davisson and Germer's experiment – G.P Thomson experiment – Gamma-ray microscope.		
Unit 2	**POSTULATES OF QUANTUM MECHANICS** Time independent Schrodinger equations - Differentia operators - Time-dependent Schrodinger equation Interpretation of wave function - Born interpretation Probability Density and Probability – Conditions fo Physical Acceptability of Wave Function – Normalization - Stationary states - Linearity and Superposition Principles - Operators - Observables - Expectation Values - Eigenvalues - Eigen functions - Eigen states - Mathematica properties of operators - Commutation relations - Hermitian property of operators - Orthonormality and Orthogonality o Eigenfunctions - Dirac Bracket notation.	12	CLO2, CLO5
Unit 3	**APPLICATION OF QUANTUM MECHANICS TO SIMPLE PHYSICAL SYSTEMS** Free Particle motion in one dimension - Particle in an infinite potential well, Particle in a box of length L degenerate and non-degenerate eigen states – Energy Eigenvalue and normalized Eigen function. Barrier penetration problems: Finite potential well –Tunnel effect - Scanning Tunneling Microscope (Principle and Working).	12	CLO3
Unit 4	**QUANTUM THEORY OF HARMONIC OSCILLATOR** Simple Harmonic Oscillator: Classical picture of Harmonic Oscillator – Quantum Harmonic Oscillator (QHO)- Solution of time-independent Schrodinger equation for QHO - Power series method - Hermite's differential equation - Hermite's Polynomials and functions – Energy Eigenfunctions Energy levels – Zero point energy.	12	CLO4, CLO5
Unit 5	**QUANTUM THEORY OF HYDROGEN–LIKE ATOMS** Schrödinger's Equation for the Hydrogen Atom (Spherical Polar Coordinates) –Separation of Variables Complete solution of time-independent Schrodinger's equation - Spherical Harmonics - Quantum Numbers: Principle - Orbital and Magnetic – Energy Eigenfunctions and Energy Eigenvalues - shapes of the probability densities for ground states.	12	CLO4, CLO5

Learning Resources	
Text Books	1. Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education. 2. Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill
Ref. Books	1. A Text of Book Mechanics, P M Mathews and K Venkatesan, 2010, McGraw-Hill 2. Quantum Mechanics, L I Schiff, 2017, McGraw-Hill 3. Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGraw Hil 4. Quantum Mechanics: Theory & Applications, A.K.Ghatak & S.Lokanathan, 2004 Macmillan 5. Modern Physics, J.R. Taylor, C.D. Zafiratos, M.A. Dubson, 2004, PHI Learning

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (100% weightage)								Final Examination (60% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (10%)		CLA – 4 (10%)			
		Theory	Practical	Theory	Practical	Theory	Practical	Theory	Practical	Theory	Practical
Level 1	Remember	50%	50%	50%	50%	30%	30%	30%	30%	30%	-
	Understand										-
Level 2	Apply	50%	50%	50%	50%	40%	40%	40%	40%	40%	-
	Analyze										-
Level 3	Evaluate	-	-	-	-	30%	30%	30%	30%	30%	-
	Create	-	-	-	-						-
		100%		100%		100%		100%		100%	-

Course Designers		
Experts from Industry: Name, Designation with official mail id	Experts from Higher Education Institutions: Name, Designation with official mail id	Internal Experts: Name, Designation with official id
Name: Dr. Jagdish Chandra Saraswatula *Designation : Director of Product Management, Brooks Automation, Germany* ***Email: Jagdish.saraswatula@gmail.com***	*ame: Prof. Prem Pal* *Designation: Professor, Indian Institute of Technology, Hyderabad.* ***Email: prem@iith.ac.in***	*Name: Dr. Nishal Rai* *Designation: Assistant professor, SRM University Sikkim* ***Email:nishalrai.g@srmus.edu.in***

Course Code	*PHY1842*	**Course Name**	*Modern Optics*	**Course Category**	*C*	*CORE*	L	T	P	C
							4	0	0	4
Pre-requisite Nil				**Co-requisite PHY 1843**						

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	**Bloom's Learning (BL) Level**	**Program Learning Outcomes (PLO)**										
			PLO-1	**PLO-2**	**PLO-3**	**PLO-4**	**PLO-5**	**PLO-6**	**PLO-7**	**PLO-8**	**PLO-9**	**PLO-10**	**PLO-11**
			Domain Specific Knowledge	Critical Thinking and Problem Solving	Inter and Multi-disciplinary Skills	Lifelong learning	Research Aptitude	Creativity	Communication Skills	Innovation and Entrepreneurship	Vocational and Industry Exposure	Environmental awareness and sustainability	Ethics
CLO-1	Comprehend and familiarize the basic concept of optics	3	H	H	H	H	H	-	-	M	M	-	H
CLO-2	Comprehend the concept of Interference and	3	H	H	H	H	H	-	-	M	M	-	H

	Diffraction												
CLO-3	Acquire the concepts of Interference, diffraction and polarization in real time situations	4	H	H	H	H	H	-	-	M	M	-	H
CLO-4	Apply the concept of optics in holography and fiber optics	4	H	H	H	-	H	M	-	-	M	-	H
CLO-5	Develop Critical Thinking and Problem Solving by applying the concepts to solving problems	4	H	H	H	H	H	-	-	M	M	-	H

(Level of correlation: ***3-High, 2-Medium, 1-Low*** can be used)

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
Unit 1	**UNIT I - INTRODUCTION TO OPTICS** Huygens principles and its applications-Fermat's Principle verification of laws of reflection and refraction, Matrix methods refraction and translation, translation matrix refraction matrix, system matrix, the position of the image	12	CLO1

	plane, magnification, system matrix for the thick lens system matrix for the thin lens. ● Determination of wavelengths of mercury spectrum using prism in minimum deviation ● Determination of wavelengths of mercury spectrum using diffraction grating in minimum deviation		
Unit 2	**INTERFERENCE** Interference by division of wavefront: Superposition of two sinusoidal waves, Interference, coherence, conditions for interference, the inference patterns, intensity distribution.Fresnel's two mirror arrangement. Interference by division of amplitude: Interference by a plane film illuminated by a plane wave, cosine law, non-reflecting films (the subsections excluded), colours of thin films, Newton's rings, The Michelson interferometer. ● Determination of refractive index of the material of the prism by drawing the i–d curve ● Spectrometer – Narrow angled prism	12	CLO2, CLO3
Unit 3	**DIFFRACTION** Fraunhofer Diffraction: single slit diffraction pattern diffraction by circular aperture, two slit Fraunhofer diffraction pattern, N slit diffraction pattern, plane diffraction grating, resolving power. ● Determination of wavelengths of mercury spectrum using diffraction grating in normal incidence ● Determination of dispersive power of a prism using spectrometer Fresnel Diffraction: Fresnel half period zones, explanation of rectilinear propagation of light, zone plate, diffraction at straight edge	12	CLO2, CLO3
Unit 4	**POLARIZATION AND HOLOGRAPHY** Double refraction – Nicol prism – polarizer and analyzer Hygiene's explanation of double refraction, positive and negative uniaxial crystals, quarter and half wave plates types of polarized light, optical activity. Principles of holography, Theory of construction and reconstruction, Hologram, Applications of Holography. ● Spectrometer– i – Ɵ curve ● Spectrometer – Cauchy's constants ● Spectrometer – refractive index of the liquid	12	CLO3, CLO4
Unit 5	**FIBER OPTICS** Fiber Optics: Total internal reflection, optical fiber (step and multi–mode), Numerical aperture, attenuation in optical fiber, multimode fibers, pulse dispersion, power law profile fiber optic sensors.	12	CLO3, CLO5

	• Determination of wavelength of sodium light – Newton's Rings • Determination of numerical aperture and acceptance angle of the optical fiber using laser		

Learning Resources	
Text Books	1. Ajoy Ghatak, *Optics*, Mc Graw Hill, 2010. 2. Subramaniam, Brijlal and Avadhanulu, *A Text book of Optics*, S. Chand, 2006
Ref. Books	1. Eugene Hecht, *Optics*, 4th Edition, Addison Wesley, 2002. 2. Brooker, Geoffrey, *Modern Classical Optics*, Oxford Univ. Press, 2003. 3. Guenther, Robert D and Robert Guenther, *Modern Optics*, Vol. 1. Wiley, 1990. 4. F. Jankins and H White, *Fundamentals of Optics*, Mc Graw Hill, 2017

Learning Assessment											
	Bloom's Level of Thinking	**Continuous Learning Assessment (100% weightage)**								**Final Examination (60% weightage)**	
		CLA – 1 (10%)		**CLA – 2 (10%)**		**CLA – 3 (10%)**		**CLA – 4 (10%)**			
		Theory	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**
Level 1	Remember	**50%**	**50%**	**50%**	**50%**	**30%**	**30%**	**30%**	**30%**	**30%**	-
	Understand										-
Level 2	Apply	**50%**	**50%**	**50%**	**50%**	**40%**	**40%**	**40%**	**40%**	**40%**	-
	Analyze										-
Level 3	Evaluate	-	-	-	-	**30%**	**30%**	**30%**	**30%**	**30%**	-
	Create	-	-	-	-						-
		100%		**100%**		**100%**		**100%**		**100%**	-

Course Designers		
Experts from Industry: Name, Designation with official mail id	Experts from Higher Education Institutions: Name, Designation with official mail id	Internal Experts: Name, Designation with official id
Name: Dr. Jagdish Chandra Saraswatula *Designation : Director of Product Management, Brooks Automation, Germany* ***Email: Jagdish.saraswatula@gmail.com***	*ame: Prof. Prem Pal* *Designation: Professor, Indian Institute of Technology, Hyderabad.* ***Email: prem@iith.ac.in***	*Name: Dr. Nishal Rai* *Designation: Assistant professor, SRM University Sikkim* ***Email:nishalrai.g@srmus.edu.in***

Course Code	*PHY23CO43*	**Course Name**	*Analog and Digital Electronics*	**Course Category**	*C*	*Core*	L	T	P	C
							4	0	0	4
Pre-requisite -NIL				**Co-requisite - PHY1854**						

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	**Bloom's Learning (BL) Level**	**Program Learning Outcomes (PLO)**										
			PLO-1	**PLO-2**	**PLO-3**	**PLO-4**	**PLO-5**	**PLO-6**	**PLO-7**	**PLO-8**	**PLO-9**	**PLO-10**	**PLO-11**
			Domain Specific Knowledge	Critical Thinking and Problem Solving	Inter and Multi-disciplinary Skills	Lifelong learning	Research Aptitude	Creativity	Communication Skills	Innovation and Entrepreneurship	Vocational and Industry Exposure	Environmental awareness and sustainability	Ethics
CLO-1	Comprehend about the basic principles of networks and semiconductors	3	H	H	H	H	H	-	-	M	M	-	H

CLO-2	Familiarize with the working principles of transistors	3	H	M	H	H	H	-	-	M	M	-	H
CLO-3	Familiarize with the working principles of amplifiers and oscillators	4	H	H	H	H	H	-	-	M	M	-	H
CLO-4	Acquire knowledge about the basics of number systems and develop digital concepts using logic gates	4	H	H	H	-	H	M	-	-	M	-	H
CLO-5	Apply the digital concepts in combinational and sequential logic systems	5	H	H	H	H	H	-	-	M	M	-	H

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
Unit 1	**NETWORK THEOREM AND SEMICONDUCTORS**	12	CLO1, CLO2

	Circuit Elements and Kirchhoff's Law – Methods of Analysing circuits – Mesh and Nodal Method – Thevenin Theorem – Norton theorem – Intrinsic and extrinsic semi conductor – PN junction diode–construction–Biasing of PN junction–VI characteristics of diode–Zener diode– Bipolar Junction Transistors – Construction–CE, CB configuration–input and output characteristics–Two port network analysis of transistor–FET – Construction and characteristics of JFET– Biasing of JFET– Depletion and Enhancement modes–Important Relationships – MOSFET– Depletion type of MOSFET – Enhancement type of MOSFET ● To verify the Thevenin theorem. ● To obtain the static characteristics of a PN junction diode and then obtain the forward resistance of the diode at a given operating point.		
Unit 2	**AMPLIFIERS AND OSCILLATORS** RC coupled single stage amplifiers–Frequency response – Feedback constant–Gain with feedback – Advantages of negative feedback amplifier–(quantitative treatment only) – Power amplifiers –Class A and Class B amplifiers,. Principle of Feedback and oscillators– Feedback amplifier— Oscillator operations – Burcausan criteria– Sinusoidal oscillators–Hartly oscillator–Colpit's oscillators–Phase shift oscillator– Wien bridge oscillator ● Study of class A and class B power amplifiers. ● Study the V–I characteristics of a Zener diode and note down its breakdown potential.	12	CLO3, CLO1
Unit 3	**WAVE SHAPING AND SWEEP CIRCUITS** Operational Amplifiers – Open loop and closed loop –OP–AMP characteristics– Ideal OP–AMP with virtual ground– Inverting and Non inverting OP–AMP–Basic OP–AMP with applications– Adder –Subtractor –Voltage follower – Clipping circuit – Positive clipper – Biased clipper – Combinations clipper – Applications of clipper– Clamping Circuits–Basic idea of a clamper – Positive clamper – negative clamper–.IC555 (Timer IC) – Astable multivibrator – Monostable multivibrator. ● Study of Diode as clipper and clamper. ● Study of timer circuit using IC555 and configuration for monostable and astable multivibrator.	12	CLO3, CLO1
Unit 4	**NUMBER SYSTEM AND LOGIC GATES**	12	CLO4

	Introduction to decimal– Binary– Octal– Hexadecimal number systems–Inter conversions–BCD code– Excess – 3 code– Gray code –One's complement andtwo's complements– Arithmetic operations– Addition– Subtraction– Basic and derived logic gates– Symbols and their truth tables– AND–OR– NOT– NAND– NOR– XOR– XNOR– Universal NAND and NOR gates– Boolean algebra – Basic laws of Boolean algebra – De–Morgan's theorems– Reducing Boolean expressions using Boolean laws– SOP and POS forms of expressions–Min term and max terms– Karnaugh map simplification ● Universal logic gates using NAND and NOR gates		
Unit 5	**COMBINATIONAL AND SEQUENTIAL LOGIC SYSTEMS** Half and full adders– Half and full subtractors– Binary adders and subtractors–Two's complement adder/subtractor circuits– Binary Coded Decimal (BCD) adder–Decoder–Encoder–Multiplexer– Demultiplexer– .Flip flop–RS flip flop – Clocked RS flip flop–D flip flops – JK flip flop – JK as master slave flip flops. ● Logic gates using Discrete components and ICs ● CE amplifier and make the (i) Upper cut off (ii) Lower cutoff frequencies and hence estimate the BW.	12	CLO5

Learning Resources	
Text Books	1. Sudhakar A and Shyammohan S Palli, *Circuits and Network Analysis andSynthesis*, 4th Edition, Tata McGraw Hill, 2010. 2. Metha V.K., Mehta R., *Principles of Electronics*, S. Chand and Company Ltd., 2008.
Ref. Books	1. Jacob Millman, Christos C Halkias, Satyabrata Jit, *Electron Devices andCircuits*, Tata McGraw Hill, 2010. 2. Millman and Halkias ,*Electronics Devices and Circuits*, Tata Mc Graw Hill,2008. 3. William H.Hyte, Jr, J.E.Kemmerly and Steven M.Durban, *Engineering CircuitAnalysis*, 7th Edition, McGraw Hill, 2010. 4. Robert L. Boylestad and Louis Nashelsky, *Electronic Devices and CircuitTheory*, Pearson Education, 9th Edition, 2009.

Learning Assessment											
	Bloom's Level of Thinking	**Continuous Learning Assessment (100% weightage)**								**Final Examination (60% weightage)**	
		CLA – 1 (10%)		**CLA – 2 (10%)**		**CLA – 3 (10%)**		**CLA – 4 (10%)**			
		Theory	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**
Level 1	Remember	**50%**	**50%**	**50%**	**50%**	**30%**	**30%**	**30%**	**30%**	**30%**	-
	Understand										-
Level 2	Apply	**50%**	**50%**	**50%**	**50%**	**40%**	**40%**	**40%**	**40%**	**40%**	-
	Analyze										-
Level 3	Evaluate	-	-	-	-	**30%**	**30%**	**30%**	**30%**	**30%**	-
	Create	-	-	-	-						-
		100%		**100%**		**100%**		**100%**		**100%**	-

Course Designers		
Experts from Industry: Name, Designation with official mail id	Experts from Higher Education Institutions: Name, Designation with official mail id	Internal Experts: Name, Designation with official id
Name: Dr. Jagdish Chandra Saraswatula *Designation : Director of Product Management, Brooks Automation, Germany* ***Email: Jagdish.saraswatula@gmail.com***	*Name: Prof. Prem Pal* *Designation: Professor, Indian Institute of Technology, Hyderabad.* *Email: prem@iith.ac.in*	*Name: Dr. Nishal Rai* *Designation: Assistant professor, SRM University Sikkim* ***Email:nishalrai.g@srmus.edu.in***

Course Code	*PHY23MI41*	Course Name	*Introduction to Quantum Theory*	Course Category	*MI*	*Minor*	L	T	P	C
							4	0	0	3
Pre-requisite			**Nil**							

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	**Bloom's Learning (BL) Level**	**Program Learning Outcomes (PLO)**										
			PLO-1	**PLO-2**	**PLO-3**	**PLO-4**	**PLO-5**	**PLO-6**	**PLO-7**	**PLO-8**	**PLO-9**	**PLO-10**	**PLO-11**
			Domain Specific Knowledge	Critical Thinking and Problem Solving	Inter and Multi-disciplinary Skills	Lifelong learning	Research Aptitude	Creativity	Communication Skills	Innovation and Entrepreneurship	Vocational and Industry Exposure	Environmental awareness and sustainability	Ethics
CLO-1	Analyze the origin and Historical development of quantum theory	3	H	H	H	H	H	-	-	M	M	-	H
CLO-2	Comprehend the idea of Wave particle duality and Uncertainty principle of quantum theory	3	H	H	H	H	H	-	-	M	M	-	H
CLO-3	Familiarize with the basic postulates of quantum theory	4	H	H	H	H	H	-	-	M	M	-	H

CLO-4	Comprehend the concept of Schrodinger wave equation of quantum theory	4	H	H	H	-	H	M	-	-	M	-	H
CLO-5	Apply Schrodinger wave equation in different quantum systems aromatic Hydrocarbons	4	H	H	H	H	H	-	-	M	M	-	H

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
Unit 1	**MATTER WAVE** Planck's constant and light as a collection of photons; Blackbody Radiation: Quantum theory of Light; Photo-electric effect and Compton scattering. De Broglie wavelength and matter waves Davisson-Germer experiment. Wave description of particles by wave packets. Group and Phase velocities and the relation	9	CLO1

	between them. Double-slit experiment with electrons. Probability Wave amplitude and wave functions.		
Unit 2	**WAVE PARTICLE DUALITY AND UNCERTAINTY PRINCIPLE** Position measurement- gamma-ray microscope though experiment; Wave-particle duality, Heisenberg uncertainty principle (Uncertainty relations involving Canonical pair o variables): Derivation from Wave Packets impossibility of a particle following a trajectory; Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle.	9	CLO2
Unit 3	**POSTULATES OF QUANTUM MECHANICS** Basic postulates of quantum mechanics, Interpretation of Wave Function– Probability Density and Probability – Conditions fo Physical Acceptability of Wave Function – Normalization – Orthogonality – Linearity and Superposition Principles – Expectation Values – Wave Function of a Free Particle.	9	CLO2, CLO3
Unit 4	**TIME INDEPENDENT SCHRODINGER EQUATION** Time independent Schrodinger equation-Hamiltonian, stationary states and energy eigenvalues; expansion of an arbitrary wavefunction as a linear combination of energy eigenfunctions. General solution of the time-dependent Schrodinger equation in terms of linear combinations of stationary states.	9	CLO4
Unit 5	**QUANTUM MECHANICS IN ONE DIMENSION** Free Particle solution and Plane Wave Normalization – Particle in an infinite potential well, Particle in a box of length L, degenerate and non-degenerate eigen states – Energy Eigenvalue and normalized Eigenfunction. Barrier penetration problems: Finite potential well –Tunnel effect.	9	CLO5

Learning Resources	
Text Books	1. Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn., 2002, Wiley. 2. Quantum Mechanics, G. Aruldhas, 2nd Edn. 2002, PHI Learning of India 3. Quantum Mechanics, Leonard I. Schiff, 3rd Edn. 2010, Tata McGraw Hill.

Ref. Books	1. Quantum Mechanics, Eugen Merzbacher, 2004, John Wiley and Sons, Inc. 2. Introduction to Quantum Mechanics, D.J. Griffith, 2nd Ed. 2005, Pearson Education 3. Quantum Mechanics, Walter Greiner, 4th Edn., 2001, Springer

Learning Assessment											
	Bloom's Level of Thinking	**Continuous Learning Assessment (100% weightage)**								**Final Examination (60% weightage)**	
		CLA – 1 (10%)		**CLA – 2 (10%)**		**CLA – 3 (10%)**		**CLA – 4 (10%)**			
		Theory	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**
Level 1	Remember	**50%**	**50%**	**50%**	**50%**	**30%**	**30%**	**30%**	**30%**	**30%**	-
	Understand										-
Level 2	Apply	**50%**	**50%**	**50%**	**50%**	**40%**	**40%**	**40%**	**40%**	**40%**	-
	Analyze										-
Level 3	Evaluate	-	-	-	-	**30%**	**30%**	**30%**	**30%**	**30%**	-
	Create	-	-	-	-						-
		100%		**100%**		**100%**		**100%**		**100%**	-

Course Designers		
Experts from Industry: Name, Designation with official mail id	Experts from Higher Education Institutions: Name, Designation with official mail id	Internal Experts: Name, Designation with official id

Name: Dr. Jagdish Chandra Saraswatula *Designation : Director of Product Management, Brooks Automation, Germany* ***Email: Jagdish.saraswatula@gmail.com***	*Name: Prof. Prem Pal* *Designation: Professor, Indian Institute of Technology, Hyderabad.* *Email: prem@iith.ac.in*	*Name: Dr. Nishal Rai* *Designation: Assistant professor, SRM University Sikkim* ***Email:nishalrai.g@srmuss.edu.in***

Course Code	*PHY23MI42*	**Course Name**	*Principle of Electronics*	**Course Category**	*MI*	*Minor*	L	T	P	C
							0	0	4	2
Pre-requisite Nil										

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	**Bloom's Learning (BL) Level**	**Program Learning Outcomes (PLO)**										
			PLO-1	**PLO-2**	**PLO-3**	**PLO-4**	**PLO-5**	**PLO-6**	**PLO-7**	**PLO-8**	**PLO-9**	**PLO-10**	**PLO-11**
			Domain Specific Knowledge	Critical Thinking and Problem Solving	Inter and Multi-disciplinary Skills	Lifelong learning	Research Aptitude	Creativity	Communication Skills	Innovation and Entrepreneurship	Vocational and Industry Exposure	Environmental awareness and sustainability	Ethics
CLO-1	Comprehend about the basic principles of networks and semiconductors	4	H	H	H	H	H	-	-	M	M	-	H
CLO-2	Familiarize with the working principles of transistors	4	H	H	H	H	H	-	-	M	M	-	H
CLO-3	Familiarize with the	4	H	H	H								

	working principles of amplifiers and oscillators					H	H	-	-	M	M	-	H
CLO-4	Acquire knowledge about the basics of number systems and develop digital concepts using logic gates	5	H	H	H	-	H	M	-	-	M	-	H
CLO-5	Apply the digital concepts in combinational and sequential logic systems	5	H	H	H	H	H	-	-	M	M	-	H

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
Unit 1	**NETWORK THEOREM AND SEMICONDUCTORS** Circuit Elements and Kirchhoff's Law – Methods of Analysing circuits – Mesh and Nodal Method– Thevenin Theorem – Norton theorem – Intrinsic and extrinsic semiconductor – PN junction diode–construction–Biasing of PN junction–VI characteristics of diode–Zener diode–Bipolar Junction Transistors – Construction-CE, CB configuration–input and output characteristics ● To verify the Thevenin theorem. ● To obtain the static characteristics of a PN junction diode and then obtain the forward resistance of the diode at a given operating point.	9	CLO1

Unit 2	**AMPLIFIERS AND OSCILLATORS** RC coupled single stage amplifiers–Frequency response – Feedback constant–Gain with feedback– Advantages of negative feedback amplifier–(quantitative treatment only) – Principle o Feedback and oscillators– Feedback amplifier— Oscillato operations – Barkhausen criteria–Sinusoidal oscillators–Hartly oscillator–Colpit's oscillators ● Study the V–I characteristics of a Zener diode and note down its breakdown potential.	9	CLO2
Unit 3	**WAVE SHAPING AND SWEEP CIRCUITS** Operational Amplifiers – Open loop and closed loop –OP–AMI characteristics– Ideal OP–AMP with virtual ground–Inverting and Non inverting OP–AMP–Basic OP–AMP with applications– Adder–Subtractor –Voltage follower – Clipping circuit – Positive clipper – Biased clipper –Combinations clipper – Clamping Circuits–Basic idea of a clamper – Positive clamper – negative clamper	9	CLO2, CLO3
Unit 4	**NUMBER SYSTEMS AND LOGIC GATES** Introduction to decimal– Binary– Octal– Hexadecimal numbe systems–Inter conversions–One's complement and two's complements– Arithmetic operations– Addition– Subtraction– Basic and derived logic gates– Symbols and their truth tables– AND–OR– NOT– NAND– NOR– XOR– XNOR– Universa NAND and NOR gates– Boolean algebra – Basic laws of Boolean algebra – De– Morgan's theorems– Reducing Boolean expressions using Boolean laws ● Study of Input and output characteristics of n-p-n transistors by CE Mode.. ● Study of Diode as clipper and clamper.	9	CLO4
Unit 5	**COMBINATIONAL AND SEQUENTIAL LOGIC SYSTEMS** Half and full adders– Half and full subtractors– Binary adders and subtractors–Two's complement adder/subtractor circuits– Binary Coded Decimal (BCD) adder–Decoder–Encoder–Multiplexer– Demultiplexer. ● Study of timer circuit using IC555 and configuration for monostable and astable multivibrator ● Logic gates using Discrete components and ICs	9	CLO5

Learning Resources	
Text Books	1. Sudhakar A and Shyammohan S Palli, Circuits and Network Analysis and Synthesis, 4 th Edition, Tata McGraw Hill, 2010. 2. Metha V.K., Mehta R., Principles of Electronics, S. Chand and Company Ltd., 2008.
Ref. Books	1. Jacob Millman, Christos C Halkias, Satyabrata Jit, Electron Devices andCircuits Tata McGraw Hill, 2010. 2. Millman and Halkias ,Electronics Devices and Circuits, Tata Mc Graw Hill,2008. 3. William H.Hyte, Jr, J.E.Kemmerly and Steven M.Durban, Engineering CircuitAnalysis, 7 th Edition, McGraw Hill, 2010. 4. Robert L. Boylestad and Louis Nashelsky, Electronic Devices and CircuitTheory, Pearson Education, 9 th Edition, 2009.

Learning Assessment											
	Bloom's Level of Thinking	**Continuous Learning Assessment (40% weightage)**								**Final Examination (60% weightage)**	
		CLA – 1 (10%)		**CLA – 2 (10%)**		**CLA – 3 (10%)**		**CLA – 4 (10%)**			
		Theory	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**
Level 1	Remember	**50%**	**50%**	**50%**	**50%**	**30%**	**30%**	**30%**	**30%**	**30%**	-
	Understand										-
Level 2	Apply	**50%**	**50%**	**50%**	**50%**	**40%**	**40%**	**40%**	**40%**	**40%**	-
	Analyze										-
Level 3	Evaluate	-	-	-	-	**30%**	**30%**	**30%**	**30%**	**30%**	-
	Create	-	-	-	-						-
		100%		**100%**		**100%**		**100%**		**100%**	-

Course Designers		
Experts from Industry: Name, Designation with official mail id	Experts from Higher Education Institutions: Name, Designation with official mail id	Internal Experts: Name, Designation with official id
Name: Dr. Jagdish Chandra Saraswatula *Designation : Director of Product Management, Brooks Automation, Germany* ***Email: Jagdish.saraswatula@gmail.com***	*Name: Prof. Prem Pal* *Designation: Professor, Indian Institute of Technology, Hyderabad.* *Email: prem@iith.ac.in*	*Name: Dr. Nishal Rai* *Designation: Assistant professor, SRM University Sikkim* ***Email:nishalrai.g@srmus.edu.in***

Semester V

Course Code	PHY23CO51	**Course Name**	*Solid State Physics*	**Course Category**	*C*	*CORE*	L	T	P	C
							3	0	2	4
Pre-requisite			None							

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	**Bloom's Learning (BL) Level**	**Program Learning Outcomes (PLO)**										
			PLO-1	**PLO-2**	**PLO-3**	**PLO-4**	**PLO-5**	**PLO-6**	**PLO-7**	**PLO-8**	**PLO-9**	**PLO-10**	**PLO-11**
			Domain Specific Knowledge	Critical Thinking and Problem Solving	Inter and Multi-disciplinary Skills	Lifelong learning	Research Aptitude	Creativity	Communication Skills	Innovation and Entrepreneurship	Vocational and Industry Exposure	Environmental awareness and sustainability	Ethics
CLO-1	Develop concepts on crystal structures and	3	H	H	H	M	H	M	-	M	-	M	H

	crystal systems												
CLO-2	Comprehend and apply the concepts of bonding in solids	4	H	H	H	H	H	M	-	M	-	H	H
CLO-3	Develop concepts on lattice vibrations, thermal properties and electric conductivity of solids	4	H	H	H	M	H	M	-	M	-	H	M
CLO-4	Comprehend and apply the concepts of dielectric properties of solids and superconductivity in various applications	5	H	H	M	H	M	M	-	-	M	H	H
CLO-5	Apply the concepts acquired in solving problems	5	H	H	H	M	H	H	-	H	-	H	M

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
Unit 1	**CRYSTAL PHYSICS** Crystalline and amorphous solids – Lattice and basis – Unit cell and primitive cell – Crystal systems – Translation vectors – Number of atoms per unit cell in a Cubic Crystal – Bravais lattice – Simple cubic– BCC FCC lattices – HCP and diamond structure – Miller indices – Interplanar spacing –Crystal symmetry – Crystal diffraction – Bragg's law – Experimental diffraction methods – Laue method – Powder diffraction method – Reciprocal lattice. • Determination of dielectric constant of a given material.	9	CLO1, CLO5
Unit 2	**BONDING IN SOLIDS**	9	CLO2, CLO5

	Crystal binding – Crystals of inert gas – Van der Walls – Cohesive energy – Compressibility and bulk modulus – Ionic Crystals – Madelung energy – Evaluation of Madelung constant – Covalent crystals – Energy value for single covalent bonds – Metallic crystals – Hydrogen bonding – Atomic radii – Tetrahedral covalent radii and ionic crystal radii. ● Determination of Planck's constant using a light-emitting diode.		
Unit 3	**LATTICE VIBRATION AND THERMAL PROPERTIES OF SOLIDS** Vibration of one dimensional monatomic linear lattice – Derivation of force constant – Dispersion relation – Brillouin zone – Phase velocity – Group velocity – Phonons – Characteristics of phonons – Phonon momentum – Thermal Properties of Solids – Classical theory of specific heat – Einstein's theory of specific heat – Debye's theory of specific heat. ● Determination of the resistivity of a given material using two probe and four probe methods.	9	CLO3, CLO5
Unit 4	**FREE ELECTRON THEORY OF METALS** Free electron theory –Fermi Dirac statistics and electronic distribution in solids – Density of energy states and Fermi energy – The Fermi distribution function –Drude Lorentz theory – Electrical conductivity – Thermal conductivity – Wied–Mann and Franz ratio – Hall effect – Hall voltage and Hall coefficient – Mobility and Hall angle – Importance of Hall effect – Experimental determination of Hall coefficient. ● Determination of Hall voltage and carrier type of a given semiconducting material. ● Trace the magnetic hysteresis loop on various magnetic materials.	9	CLO3, CLO4
Unit 5	**DIELECTRICS AND SUPERCONDUCTIVITY** Dielectrics – Dielectric constant and displacement vecto r– Clausissmossotti relation – Atomic or molecular polarizability – Types of polarizability – Superconductivity – Occurrence of superconductivity – Destruction of superconductivity by magnetic fields – Meissner effect – London equation – Josephson effect – Energy gap – Elements of BCS theory – Classification of Superconductivity – Application ● Determination of magnetic susceptibility of a given paramagnetic liquid by the Quincke method**.**	9	CLO4, CLO5

Additional 30 hours for practical

Learning Resources	
Text Books	1. Pillai S.O., *Soild State Physics*, 6th Edition, New Age Science, 2013. 2. Charles Kittel, *Introduction to Solid State Physics*, Wiley, 2005.
Ref. Books	1. Ashcroft W. and Mermin N.D., *Solid State Physics, H*olt–Rinehart–Winston, 1976. 2. Blakemore J. S., Solid State Physics, 2nd Edition, Cambridge University Press, Cambridge, 1974. 3. Dekker A. J., *Solid State Physics*, Mac Millan, 1971. 4. Giuseppe Grosso, Giuseppe Pastori Parravicini, *Solid State Physics,* Academic Press, Second Edition, 2014.

Learning Assessment											
	Bloom's Level of Thinking	**Continuous Learning Assessment (40% weightage)**								**Final Examination (60% weightage)**	
		CLA – 1 (10%)		**CLA – 2 (10%)**		**CLA – 3 (10%)**		**CLA – 4 (10%)**			
		Theory	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**
Level 1	Remember	**50%**	**50%**	**50%**	**50%**	**30%**	**30%**	**30%**	**30%**	**30%**	**-**
	Understand										**-**
Level 2	Apply	**50%**	**50%**	**50%**	**50%**	**40%**	**40%**	**40%**	**40%**	**40%**	**-**
	Analyze										**-**
Level 3	Evaluate	**-**	**-**	**-**	**-**	**30%**	**30%**	**30%**	**30%**	**30%**	**-**
	Create	**-**	**-**	**-**	**-**						**-**
		100%		**100%**		**100%**		**100%**		**100%**	**-**

Course Designers		
Experts from Industry: Name, Designation with official mail id	Experts from Higher Education Institutions: Name, Designation with official mail id	Internal Experts: Name, Designation with official id
Name: Dr. Jagdish Chandra Saraswatula *Designation : Director of Product*	*Name: Prof. Prem Pal* *Designation: Professor, Indian Institute of Technology,*	*Name: Dr. Nishal Rai* *Designation: Assistant professor, SRM University*

Management, Brooks Automation, Germany ***Email: Jagdish.saraswatula@gmail.com***	*Hyderabad.* *Email: prem@iith.ac.in*	*Sikkim* ***Email:nishalrai.g@srmus.edu.in***

Course Code	*PHY23CO52*	**Course Name**	*Statistical Mechanics*	**Course Category**	*C*	*Core*	L	T	P	C
							3	1	0	4
Pre-requisite			None							

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	**Bloom's Learning (BL) Level**	**Program Learning Outcomes (PLO)**										
			PLO-1	**PLO-2**	**PLO-3**	**PLO-4**	**PLO-5**	**PLO-6**	**PLO-7**	**PLO-8**	**PLO-9**	**PLO-10**	**PLO-11**
			Domain Specific Knowledge	Critical Thinking and Problem Solving	Inter and Multi-disciplinary Skills	Lifelong learning	Research Aptitude	Creativity	Communication Skills	Innovation and Entrepreneurship	Vocational and Industry Exposure	Environmental awareness and sustainability	Ethics
CLO-1	Acquaint the basic statistical methods and concepts like probability, random variables, expected value, variance, estimators, and common	3	H	H	H	M	H	M	-	M	-	M	H

	probability function												
CLO-2	Comprehend the relation between microscopic and macroscopic description through statistical mechanics	4	H	H	H	H	H	M	-	M	-	H	H
CLO-3	Emphasize the significance of classical and quantum statistics	4	H	H	H	M	H	M	-	M	-	H	M
CLO-4	Acquaint with different types of ensembles in the relation between statistics and thermodynamics, quantum statistics, and other related phenomena	4	H	H	M	H	M	M	-	-	M	H	H
CLO-5	Acquaint with the significance of different types of statistics distribution and particles	5	H	H	H	M	H	H	-	H	-	H	M

(Level of correlation: ***3-High, 2-Medium, 1-Low*** can be used)

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
Unit 1	**Basic Statistics and Phase Space** Probability - distribution functions - Binomial distribution - Probability distribution for large–scale N - Guassian probability distributions - Basic postulates of Statistical Physics - Specification of states - Macro state - Micro State - Phase Space - Density distribution in phase space and its division - Statistical average values - Condition of equilibrium - Stirling's Approximation - Entropy and Thermodynamic probability ($S=K \ln \Omega$) - Boltzmann entropy relation.	12	CLO1, CLO2
Unit 2	**Ensembles and Thermodynamic Connections**	12	CLO2, CLO4

	Definition - Micro–canonical - Canonical and Grand Canonical ensembles - their thermodynamic connections - Statistical definition of temperature and interpretation of second law of thermodynamics – Pressure - Entropy and Chemical potential - Entropy of mixing and Gibb's paradox - Partition function and Physical significances of various statistical quantities.		
Unit 3	**Classical Statistics** Maxwell–Boltzmann statistics and Distribution law - Energy distribution function - Maxwell–Boltzmann law of velocity distribution (most probable velocity - average velocity, RMS velocity) - Limitations of M–B statistics.	12	CLO3, CLO5
Unit 4	**Bose–Einstein Statistics** Bridging Microscopic and Macroscopic behavior - indistinguishability of particles and its consequences - Transition to quantum statistics and its implications - Bose–Einstein Statistics B–E distribution law - Thermodynamic functions of a Completely Degenerate Bose Gas - Bose–Einstein condensation, properties of liquid He (qualitative description) - Radiation as photon gas - Bose's derivation of Planck's law.	12	CLO4, CLO5
Unit 5	**Fermi–Dirac Statistics** Fermi–Dirac Statistics - Fermi–Dirac Distribution Law - Thermodynamic functions of an ideal Completely Degenerate Fermi Gas - Fermi Energy - Electron gas in a Metal - Specific Heat of Metals.	12	CLO4, CLO5

Learning Resources	
Text Books	1. B.B.Laud "Introductions to Statistical Mech."(McMillan) 2. Bhattarjee J.K. "Statistical Physics", (Allied Publishers)
Ref. Books	1. F.Reif, "*Statistical Physics*", (Mc.Graw Hill) 2. Kamal Singh "*Elements of Statistical Mechanics*", (S.Chand). 3. K.Hung "*Statistical Physics*"(Chapman and Hall/CRC)

Learning Assessment											
	Bloom's Level of Thinking	**Continuous Learning Assessment (40% weightage)**								**Final Examination (60% weightage)**	
		CLA – 1 (10%)		**CLA – 2 (10%)**		**CLA – 3 (10%)**		**CLA – 4 (10%)**			
		Theory	**Other Assessment**	**Theory**	**Ohter Assessment**	**Theory**	**Other Assessmentl**	**Theory**	**Other Assessment**	**Theory**	**Other Assessment**
Level 1	Remember	**50%**	**50%**	**50%**	**50%**	**30%**	**30%**	**30%**	**30%**	**30%**	**-**
	Understand										**-**
Level 2	Apply	**50%**	**50%**	**50%**	**50%**	**40%**	**40%**	**40%**	**40%**	**40%**	**-**
	Analyze										**-**
Level 3	Evaluate	**-**	**-**	**-**	**-**	**30%**	**30%**	**30%**	**30%**	**30%**	**-**
	Create	**-**	**-**	**-**	**-**						**-**
		100%		**100%**		**100%**		**100%**		**100%**	**-**

Course Designers		
Experts from Industry: Name, Designation with official mail id	Experts from Higher Education Institutions: Name, Designation with official mail id	Internal Experts: Name, Designation with official id
Name: Dr. Jagdish Chandra Saraswatula *Designation : Director of Product Management, Brooks Automation, Germany* ***Email: Jagdish.saraswatula@gmail.com***	*Name: Prof. Prem Pal* *Designation: Professor, Indian Institute of Technology, Hyderabad.* *Email: prem@iith.ac.in*	*Name: Dr. Nishal Rai* *Designation: Assistant professor, SRM University Sikkim* ***Email:nishalrai.g@srmus.edu.in***

Course Code	*PHY23CO53*	Course Name	*Atomic Physics*	Course Category	*C*	*Core*	L	T	P	C
							3	0	2	4
Pre-requisite			None							

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	**Bloom's Learning (BL) Level**	**Program Learning Outcomes (PLO)**										
			PLO-1	**PLO-2**	**PLO-3**	**PLO-4**	**PLO-5**	**PLO-6**	**PLO-7**	**PLO-8**	**PLO-9**	**PLO-10**	**PLO-11**
			Domain Specific Knowledge	Critical Thinking and Problem Solving	Inter and Multi-disciplinary Skills	Lifelong learning	Research Aptitude	Creativity	Communication Skills	Innovation and Entrepreneurship	Vocational and Industry Exposure	Environmental awareness and sustainability	Ethics
CLO-1	Comprehend about the basic principles of atomic physics and apply skills to solve advance problems of Atomic structure	5	H	H	H	M	H	M	-	M	-	M	H
CLO-2	Familiarize with the various atomic models and atomic spectra	5	H	H	H	H	H	M	-	M	-	H	H

CLO-3	Comprehend about the electric and magnetic field effects of atomic spectra	5	H	H	H	M	H	M	-	M	-	H	M
CLO-4	Familiarize with the basic principles of X-ray spectra	4	H	H	M	H	M	M	-	-	M	H	H
CLO-5	Acquire knowledge about principles and molecular spectroscopy, and basic concepts about Raman spectroscopy	4	H	H	H	M	H	H	-	H	-	H	M

(Level of correlation: ***3-High, 2-Medium, 1-Low*** can be used)

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
Unit 1	**ATOMIC STRUCTURE I** Early models of the atom – Rutherford's experiment – Rutherford model of the atom – Bohr model of the atom – Bohr's theory of hydrogen spectrum – Spectral series and energy levels of hydrogen atom – Bohr's correspondence principle – Sommerfeld theory of hydrogen atom – Sommerfeld's relativistic theory ● Photo-electric effect: photocurrent versus intensity and wavelength of light ● Photo-electric effect: Maximum energy of photo-electrons versus frequency of light	9	CLO1
Unit 2	**ATOMIC STRUCTURE II** Vector atom model – Quantum numbers associated with vector atom model – The exclusion principle and the periodic table – Coupling schemes – Fine structure of spectral lines – Term symbol – Stern–Gerlach experiment – Interpretation of results –Normal and Anomalous Zeeman effect – Paschen Back and Stark effects ● Determination of Planck's constant using photovoltaic cell.	9	CLO2, CLO1, CLO3
Unit 3	**X -RAY SPECTRA** Origin of X–ray spectra – Continuous and Characteristic X–rays –	9	CLO4

	Moseley's law–Absorption of X–rays – Hydrogen like character of X–ray spectrum – X–ray absorption spectrum. Compton Effect – derivation of expression for change in wavelength – experimental verification. ● Study of spectral lines using spectrometers for different sources.		
Unit 4	**MOLECULAR SPECTRA** Basic elements of spectroscopy – Rotational spectra of rigid diatomic molecules – Isotopic shift and Intensities of spectral lines – Vibrational, Rotation–Vibration spectra of diatomic molecules – Introduction to Electronic spectra of molecules. ● Determination of Planck's constant using light emitting diodes.	9	CLO5
Unit 5	**RAMAN SPECTRA** Raman scattering – classical description – Theoretical explanation based on quantum theory – Characteristic properties of Raman lines – Stoke's and Anti–Stoke's Lines – Vibrational and rotational Raman spectra of diatomic and polyatomic molecules –Structure determination from Raman and Infrared spectroscopy. ● Determination of Lande-g factor.	9	CLO5

Additional 30 hours for practical

Learning Resources	
Text Books	1. Subrahmanyam N, Brij Lal, Jevan Shesan, *Atomic and Nuclear Physics*, 3rd Edition, S Chand and Company Ltd, 1986. 2. Banwell C N, McCash E M, *Fundamentals of Molecular Spectroscopy*, Tata McGraw-Hill, 2008
Ref. Books	1. Beiser A, *Concepts of Modern Physics*, 6th Edition, Mc–Graw Hill, 2009 2. Christopher J. Foot, *Atomic Physics*, Oxford University Press, 2005 3. Krane K S, *Modern Physics*, Wiley, 2016 4. Singh R. B, *Introduction to Modern Physics*, New Age International (P) Limited Publishers, 2009

Learning Assessment											
	Bloom's Level of Thinking	**Continuous Learning Assessment (40% weightage)**								**Final Examination (60% weightage)**	
		CLA – 1 (10%)		**CLA – 2 (10%)**		**CLA – 3 (10%)**		**CLA – 4 (10%)**			
		Theory	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**
Level 1	Remember	**50%**	**50%**	**50%**	**50%**	**30%**	**30%**	**30%**	**30%**	**30%**	-
	Understand										-
Level 2	Apply	**50%**	**50%**	**50%**	**50%**	**40%**	**40%**	**40%**	**40%**	**40%**	-
	Analyze										-
Level 3	Evaluate	-	-	-	-	**30%**	**30%**	**30%**	**30%**	**30%**	-
	Create	-	-	-	-						-
		100%		**100%**		**100%**		**100%**		**100%**	-

Course Designers		
Experts from Industry: Name, Designation with official mail id	Experts from Higher Education Institutions: Name, Designation with official mail id	Internal Experts: Name, Designation with official id
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Course Code	*PHY23CO54*	**Course Name**	*Semiconductor Devices*	**Course Category**	*C*	*Core*	L	T	P	C
							3	1	0	4
Pre-requisite			None							

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	**Bloom's Learning (BL) Level**	**Program Learning Outcomes (PLO)**										
			PLO-1	**PLO-2**	**PLO-3**	**PLO-4**	**PLO-5**	**PLO-6**	**PLO-7**	**PLO-8**	**PLO-9**	**PLO-10**	**PLO-11**
			Domain Specific Knowledge	Critical Thinking and Problem Solving	Inter and Multi-disciplinary Skills	Lifelong learning	Research Aptitude	Creativity	Communication Skills	Innovation and Entrepreneurship	Vocational and Industry Exposure	Environmental awareness and sustainability	Ethics
CLO-1	Comprehend the concept on structures and basic properties of semiconductors	3	H	H	H	M	H	M	-	M	-	M	H
CLO-2	Comprehend the idea on quantum theory of solids and its related principles.	4	H	H	H	H	H	M	-	M	-	H	H
CLO-3	Develop concepts about the physics of semiconductor junctions	4	H	H	H	M	H	M	-	M	-	H	M
CLO-4	Develop knowledge about the basic operations of semiconductor devices	5	H	H	M	H	M	M	-	-	M	H	H
CLO-5	Familiarize with the fabrication technology and principles of operation of new and future electronic and photonic devices based on semiconductors	5	H	H	H	M	H	H	-	H	-	H	M

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
Unit 1	**STRUCTURAL PROPERTIES OF SEMICONDUCTORSS** Crystal Structure –Space lattices – Primitive and unit cell– Types of crystal structures – Crystal planes and Miller Indices– Energy Bands and origin of Energy Gap – Carrier Concentration at Thermal Equilibrium – Carrier–Transport Phenomena – Phonon, Optical, and Thermal Properties of solids – Imperfections in Solids	12	CLO1, CLO2
Unit 2	**QUANTUM THEORY OF SOLIDS** Principles of quantum mechanics – wave particle duality – de–Broglie hypothesis – The uncertainty principle – The physical meaning of Schrodinger's Wave equation – wave equation – the Infinite Potential well– the Step Potential Function – allowed energy bands–forbidden zones	12	CLO3, CLO1
Unit 3	**DEVICE BUILDING BLOCKS** OHomo and Heterojunctions – Depletion Region – Current–Voltage Characteristics – Junction Breakdown – Transient Behavior and Noise – Terminal Functions – Heterojunctions – Formation of barriers – Current Transport Processes – Measurement of Barrier Height – Device Structures – Ideal MIS Capacitor – Silicon MOS Capacitor.	12	CLO3, CLO1
Unit 4	**TRANSISTORS AND POWER DEVICES** The Basic Principle of Operation – Simplified Transistor Current Relations– The Modes of Operation Amplification with Bipolar Transistors –Static Characteristics – Microwave Characteristics – Device Scaling and Short–Channel Effects – Nonvolatile Memory Devices – JFETs, MESFETs, and MODFETs –Tunnel Devices – IMPATT devices – Real–Space–Transfer Devices.	12	CLO4
Unit 5	**OPTICAL DEVICES** Optical Absorption –Photon Absorption Coefficient – Electron–Hole Pair Generation Rate – Emission	12	CLO5

	processes –Photoluminescence and Electroluminescence – Basic Transitions – Luminescent Efficiency – Materials –Solar Cells – The PN Junction Solar Cell – Conversion Efficiency and Solar concentration– Non–uniform Absorption Effects – Amorphous Silicon Solar Cells – Tandem cells– Photodetectors– Photoconductors–phototransistors		

Learning Resources	
Text Books	1. Donald A. Neamen, Semiconductor Physics and Devices – Basic Principles, 3 rd edition, McGraw–Hill Higher– Education 2003. 2. S M Sze, Physics of Semiconductor Devices, 2 nd edition, John Wiley & Sons, Inc 2007.
Ref. Books	1. Peter YU, Fundamentals of Semiconductors: Physics and Materials Properties (Graduate Texts in Physics), 4 th edition,2010. 2. Jacques I Pankove, Optical Processes in Semiconductors 2 nd edition, Dover Books on Physics, 2010.

Learning Assessment											
	Bloom's Level of Thinking	**Continuous Learning Assessment (40% weightage)**								**Final Examination (60% weightage)**	
		CLA – 1 (10%)		**CLA – 2 (10%)**		**CLA – 3 (10%)**		**CLA – 4 (10%)**			
		Theory	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**
Level 1	Remember	**50%**	**50%**	**50%**	**50%**	**30%**	**30%**	**30%**	**30%**	**30%**	-
	Understand										-
Level 2	Apply	**50%**	**50%**	**50%**	**50%**	**40%**	**40%**	**40%**	**40%**	**40%**	-
	Analyze										-
Level 3	Evaluate	-	-	-	-	**30%**	**30%**	**30%**	**30%**	**30%**	-
	Create	-	-	-	-						-
		100%		**100%**		**100%**		**100%**		**100%**	-

Course Designers		
Experts from Industry: Name, Designation with official mail id	Experts from Higher Education Institutions: Name, Designation with official mail id	Internal Experts: Name, Designation with official id
Name: Dr. Jagdish Chandra Saraswatula *Designation : Director of Product Management, Brooks Automation, Germany* ***Email: Jagdish.saraswatula@gmail.com***	*Name: Prof. Prem Pal* *Designation: Professor, Indian Institute of Technology, Hyderabad.* *Email: prem@iith.ac.in*	*Name: Dr. Nishal Rai* *Designation: Assistant professor, SRM University Sikkim* ***Email:nishalrai.g@srmus.edu.in***

Course Code	PHY23MI51	**Course Name**	Concepts of Atomic Physics	**Course Category**	*MI*	*Minor*	L	T	P	C
							3	1	0	4
Pre-requisite										

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	**Bloom's Learning (BL) Level**	**Program Learning Outcomes (PLO)**										
			PLO-1	**PLO-2**	**PLO-3**	**PLO-4**	**PLO-5**	**PLO-6**	**PLO-7**	**PLO-8**	**PLO-9**	**PLO-10**	**PLO-11**
			Domain Specific Knowledge	Critical Thinking and Problem Solving	Inter and Multi-disciplinary Skills	Lifelong learning	Research Aptitude	Creativity	Communication Skills	Innovation and Entrepreneurship	Vocational and Industry Exposure	Environmental awareness and sustainability	Ethics
CLO-1	Comprehend about the basic principles of atomic physics and apply skills to solve advance problems of Atomic structure	3	H	H	H	M	H	M	-	M	-	M	H
CLO-2	Familiarize with the various	4	H	H	H	H	H	M	-	M	-	H	H

	atomic models and atomic spectra for single electron atom												
CLO-3	Comprehend about the atomic models for multi electron atomic structure.	4	H	H	H	M	H	M	-	M	-	H	M
CLO-4	Comprehend about the electric and magnetic field effects of atomic spectra	5	H	H	M	H	M	M	-	-	M	H	H
CLO-5	Familiarize with the basic principles of X-ray spectra	5	H	H	H	M	H	H	-	H	-	H	M

(Level of correlation: ***3-High, 2-Medium, 1-Low*** can be used)

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
Unit 1	**BASICS OF ATOMIC STRUCTURE** Early models of the atom – Rutherford model of the atom – Bohr model of the atom – Bohr's theory of hydrogen spectrum – Spectral series and energy levels of hydrogen atom -Sommerfeld theory of hydrogen atom.	12	CLO1, CLO2
Unit 2	**QUANTUM MECHANICAL DESCRIPTION OF H - LIKE ATOM** Spectral states of H-atom - Radiative transitions - selection rules - Orbital magnetic moment of H-atom - Larmour precession - Stern - Gerlach experiment - Interpretation of results - Spin-orbit coupling - Fine structure of spectral lines.	12	CLO1, CLO2, CLO3
Unit 3	**MULTI ELECTRON ATOMIC STRUCTURE** Quantum Mechanical description of multi electron system - Pauli's Exclusion principle - Electronic configuration - Interpretation of Pauli Exclusion principle	12	CLO1, CLO5

	-Coupling schemes - LS and jj coupling - Term symbol. Spectra of Helium and Alkali like atoms.		
Unit 4	**ATOMIC SPECTRA IN ELECTRIC AND MAGNETIC FIELDS** Normal Zeeman effect - Anomalous Zeeman effect - Lande g-factor - Paschen Back effect - Stark effect. Elements of NMR and ESR.	12	CLO4
Unit 5	**X–RAY SPECTRA** Interaction of radiation with matter - Thomson scattering - Photoelectric effect - Compton scattering - Pair production. Origin of X–ray spectra – Continuous and Characteristic X–rays – Fine structure of X- ray lines - Auger transition - Moseley's law.	12	CLO1, CLO3, CLO5

Learning Resources	
Text Books	1. Subrahmanyam N, Brij Lal, Jevan Shesan, Atomic and Nuclear Physics, 3 rd Edition, S Chand and Company Ltd, 1986. 2. Christopher J. Foot, Atomic Physics, Oxford University press, 2005.
Ref. Books	1. Beiser A, Concepts of Modern Physics, 6 th Edition, Mc–Graw Hill, 2009 2. Krane K S, Modern Physics, Wiley, 2016 3. Singh R. B, Introduction to Modern Physics, New Age International (P) Limited Publishers, 2009

Learning Assessment											
	Bloom's Level of Thinking	**Continuous Learning Assessment (40% weightage)**								**Final Examination (60% weightage)**	
		CLA – 1 (10%)		**CLA – 2 (10%)**		**CLA – 3 (10%)**		**CLA – 4 (10%)**			
		Theory	**Other Assessment**	**Theory**	**Other Assessment**	**Theory**	**Other Assessment**	**Theory**	**Other Assessment**	**Theory**	**Other Assessment**
Level 1	Remember	**50%**	**50%**	**50%**	**50%**	**30%**	**30%**	**30%**	**30%**	**30%**	**-**
	Understand										**-**
Level 2	Apply	**50%**	**50%**	**50%**	**50%**	**40%**	**40%**	**40%**	**40%**	**40%**	**-**
	Analyze										**-**
Level 3	Evaluate	**-**	**-**	**-**	**-**	**30%**	**30%**	**30%**	**30%**	**30%**	**-**
	Create	**-**	**-**	**-**	**-**						**-**
		100%		**100%**		**100%**		**100%**		**100%**	**-**

Course Designers		
Experts from Industry: Name, Designation with official mail id	Experts from Higher Education Institutions: Name, Designation with official mail id	Internal Experts: Name, Designation with official id
Name: Dr. Jagdish Chandra Saraswatula *Designation : Director of Product Management, Brooks Automation, Germany* ***Email: Jagdish.saraswatula@gmail.com***	*Name: Prof. Prem Pal* *Designation: Professor, Indian Institute of Technology, Hyderabad.* *Email: prem@iith.ac.in*	*Name: Dr. Nishal Rai* *Designation: Assistant professor, SRM University Sikkim* ***Email:nishalrai.g@srmus.edu.in***

Semester VI

Course Code	PHY23CO61	**Course Name**	*Nuclear Physics*	**Course Category**	*C*	*Core*	L	T	P	C
							3	1	0	4
Pre-requisite			None							

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	**Bloom's Learning (BL) Level**	**Program Learning Outcomes (PLO)**										
			PLO-1	**PLO-2**	**PLO-3**	**PLO-4**	**PLO-5**	**PLO-6**	**PLO-7**	**PLO-8**	**PLO-9**	**PLO-10**	**PLO-11**
			Domain Specific Knowledge	Critical Thinking and Problem Solving	Inter and Multi-disciplinary Skills	Lifelong learning	Research Aptitude	Creativity	Communication Skills	Innovation and Entrepreneurship	Vocational and Industry Exposure	Environmental awareness and sustainability	Ethics
CLO-1	Comprehend the basic characteristics of the nucleus and nuclear properties	3	H	H	H	M	H	M	-	M	-	M	H
CLO-2	Comprehend the concepts of various nuclear models	3	H	H	H	H	H	M	-	M	-	H	H
CLO-3	Acquaint with the different modes of decay and interaction of nuclear radiations with matter	4	H	H	H	M	H	M	-	M	-	H	M
CLO-4	Comprehend the basic principles of accelerators and nuclear detectors	5	H	H	M	H	M	M	-	-	M	H	H

CLO-5	Comprehend the basic interaction between fundamental particles	5	H	H	H	M	H	H	-	H	-	H	M

(Level of correlation: ***3-High, 2-Medium, 1-Low*** can be used)

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
Unit 1	**NUCLEAR PROPERTIES** Constituents of nucleus and their Intrinsic properties – quantitative facts about size – mass – charge density (matter energy) – binding energy (B.E.) – average binding energy and its variation with mass number – main features of B.E. vs Mass Number curve – Neutrons vs Nucleons plot– angular momentum – parity – magnetic moment – electric moments.	12	CLO1
Unit 2	**NUCLEAR MODELS** Properties of nuclear forces and saturation – Non–existence of electrons in the nucleus and neutron proton model – Assumptions of liquid drop model – semi–empirical mass formula – conditions of nuclear stability – Nuclear Shell Model – Experimental evidence of magic numbers and its explanation.	12	CLO1, CLO2
Unit 3	**NUCLEAR PROCESSES** Radioactivity: Alpha emission – qualitative discussion of alpha spectra – Geiger–Nuttal rule – Beta emission – qualitative discussion of beta spectra–positron emission – electron capture – Neutrino hypothesis of beta decay – Evidence of existence of Neutrino – gamma–ray emission – qualitative discussion of gamma–ray spectra – internal conversion. Interaction with Matter: Energy loss due to ionization (Bethe–Bloch formula) – Energy loss of electrons – Gamma–ray through matter – pair production– radiation loss by fast electrons – electron–positron annihilation.	12	CLO3
Unit 4	**ACCELERATION AND DETECTION**	12	CLO4

	Accelerators: Cyclotron – Van–de–graaff generator – Qualitative discussion of Synchrotron – Linear accelerators.Detectors: Ionization chamber – G.M. counter – Basic principle of Scintillation Detectors and construction of photo–multiplier tube (PMT) – Semiconductor Detectors (Si and Ge) for charge particle and photon detection.		
Unit 5	**INTRODUCTION OF ELEMENTARY PARTICLES** Elementary particles and their classification – types of fundamental interactions – Conservation laws and quantum numbers – concepts of isospin – strangeness – charge conjugation – antiparticles– introduction to quarks – leptons – hadrons – qualitative discussion of the quark model.	12	CLO4, CLO5

Learning Resources	
Text Books	1. Mittal, V.K., Verma R.C. and Gupta S.C, Introduction to Nuclear and Particle Physics, PHI Learning, 3rd Edition, 2013 2. Kaplan, I.,Nuclear Physics, Narosa Publishers, 2002. 3. Ghoshal S.N.,Nuclear Physics, S. Chand, 2 nd Edition, 1994.
Ref. Books	1. Segre E., Nuclei & Particles, W.A. Benjamin Inc., 1965. 2. Krane K. S., Introductory Nuclear Physics, John–Wiley, 1987. 3. Cohen, B.L., Concepts of Nuclear Physics, TMH Edition, 1971. 4. Verma, J.,Fundamentals of Nuclear Physics, CBS, 2013

Learning Assessment											
	Bloom's Level of Thinking	**Continuous Learning Assessment (40% weightage)**								**Final Examination (60% weightage)**	
		CLA – 1 (10%)		**CLA – 2 (10%)**		**CLA – 3 (10%)**		**CLA – 4 (10%)**			
		Theory	**Other Assessment**	**Theory**	**Other Assessment**	**Theory**	**Other Assessment**	**Theory**	**Other Assessment**	**Theory**	**Other Assessment**
Level 1	Remember	**50%**	**50%**	**50%**	**50%**	**30%**	**30%**	**30%**	**30%**	**30%**	-
	Understand										-
Level 2	Apply	**50%**	**50%**	**50%**	**50%**	**40%**	**40%**	**40%**	**40%**	**40%**	-
	Analyze										-
Level 3	Evaluate	-	-	-	-	**30%**	**30%**	**30%**	**30%**	**30%**	-
	Create	-	-	-	-						-
		100%		**100%**		**100%**		**100%**		**100%**	-

Course Designers		
Experts from Industry: Name, Designation with official mail id	Experts from Higher Education Institutions: Name, Designation with official mail id	Internal Experts: Name, Designation with official id
Name: Dr. Jagdish Chandra Saraswatula *Designation : Director of Product Management, Brooks Automation, Germany* ***Email: Jagdish.saraswatula@gmail.com***	*Name: Prof. Prem Pal* *Designation: Professor, Indian Institute of Technology, Hyderabad.* *Email: prem@iith.ac.in*	*Name: Dr. Nishal Rai* *Designation: Assistant professor, SRM University Sikkim* ***Email:nishalrai.g@srmus.edu.in***

Course Code	*PHY23CO62*	**Course Name**	*Astrophysics*	**Course Category**	*C*	*Core*	L	T	P	C
							3	1	0	4
Pre-requisite			None							

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	**Bloom's Learning (BL) Level**	**Program Learning Outcomes (PLO)**										
			PLO-1	**PLO-2**	**PLO-3**	**PLO-4**	**PLO-5**	**PLO-6**	**PLO-7**	**PLO-8**	**PLO-9**	**PLO-10**	**PLO-11**
			Domain Specific Knowledge	Critical Thinking and Problem Solving	Inter and Multi-disciplinary Skills	Lifelong learning	Research Aptitude	Creativity	Communication Skills	Innovation and Entrepreneurship	Vocational and Industry Exposure	Environmental awareness and sustainability	Ethics
CLO-1	Describe the nature, structure, distribution, and formation of astronomical objects, including planets, stars, and galaxies, and the history of the universe	3	H	M	H	H	H	M	-	H	-	M	H
CLO-2	Demonstrate an appreciation of	3	H	H	H	H	M	M	-	M	-	H	H

	the universality of physical laws and apply these laws to Explain phenomena in astronomical systems and the universe												
CLO-3	Define and interpret the observational properties of astronomical objects	4	M	H	H	M	H	M	-	M	-	H	M
CLO-4	Propose, plan, and conduct astronomical observations with professional telescopes.	4	M	H	M	H	M	M	-	-	M	H	H
CLO-5	View the existence of the Universe through logical and critical reasoning	5	H	H	H	M	H	M	-	H	-	H	M

(Level of correlation: ***3-High, 2-Medium, 1-Low*** can be used)

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
Unit 1	**INTRODUCING ASTRONOMY** Review of Frames of references and special relativity - relativistic energy and relativistic momentum- relativistic Doppler effect - red shift of galaxies - Kepler's laws - Elliptical orbits - Virial Theorem - Black body radiation - spectral radiance - radiative flux - luminosity. Solar system overview- Constituents - Criteria of defining planets - brief overview of exosolar planets. Astronomical measurements - Units of length, time and mass - Motion of the Sky- Celestial Sphere - coordinates systems - Positions- Equinoxes and Solstice - Stellar	12	CLO1

	parallax - parsec scale - The Magnitude scale - Apparent and Absolute magnitudes.		
Unit 2	**SOLAR PHYSICS** Model of Sun - Core - Thermonuclear energy generation - Radiative Zone - Convective Zone - Photosphere - Solar Atmosphere - Chromosphere - Corona. Solar Magnetic activity - Sunspots - Solar activity cycle - Active Sun - Solar Neutrino problem.	12	CLO2
Unit 3	**STELLAR ASTROPHYSICS** Classification of stars - Binary stars - Mass determination using visual binaries. Theory of Stellar Evolution: Stellar Evolution cycle - Protostars - Main sequence stars - Hydrostatic equilibrium - Red Giant phase - Nuclear burning - Asymptotic Giant phase - Planetary Nebulae - Chandrasekhar Limit - Formation of White Dwarf. Massive stars - Supergiant phase - Type II supernova explosion - stellar collapse - TOV limit - Formation of Neutron stars and black holes. The Hertzsprung-Russell Diagram - Interpretation. Basics of Stellar Nucleosynthesis - Equations of stellar structure - Scaling relations (brief overview).	12	CLO3
Unit 4	**HIGH ENERGY ASTROPHYSICS** Novae outburst and Type I Supernovae - Pulsars - Gamma ray bursts - Black hole X-ray binaries - Accreting black holes - Supermassive black hole activity - quasars - AGNs. Overview of UV, X-ray and Gamma ray astronomy - Elements of Radio astronomy.	12	CLO4
Unit 5	**GALACTIC, EXTRA-GALACTIC ASTROPHYSICS & COSMOLOGY** Classification of galaxies - Mass and Motions in the Milky Way-The Galactic Centre and Edge-Density Waves and Spiral Arms - Overview of Dark matter - ISM - IGM -ICM - Distances of Galaxies -Hubble's Law - Chronology of the Physical Universe - Thermal History of the Universe - Very Early and early Universe - Big bang nucleosynthesis - Expansion history of the Universe - Radiation and Matter dominated era - CMBR and Photon Decoupling - Current accelerated expansion of the Universe - Dark energy - Newtonian Cosmology.	12	CLO5, CLO4

Learning Resources	
Text Books	1. Modern Astrophysics, B.W. Carroll & D.A. Ostlie, Addison-Wesley Publishing Co 2. Introductory Astronomy and Astrophysics, M. Zeilik and S.A. Gregory, 4th Edition, Saunders College Publishing
Ref. Books	1. The physical universe: An introduction to astronomy, F.Shu, Mill Valley: University Science Books. 2. Fundamental of Astronomy (Fourth Edition), H. Karttunen et al. Springer 3. K.S. Krishnasamy, 'Astro Physics a modern perspective,' Reprint, New Age International (p) Ltd, New Delhi,2002. 4. Baidyanath Basu, 'An introduction to Astro physics', Second printing, Prentice - Hall of India Private limited, New Delhi,2001.

Learning Assessment											
	Bloom's Level of Thinking	**Continuous Learning Assessment (40% weightage)**								**Final Examination (60% weightage)**	
		CLA – 1 (10%)		**CLA – 2 (10%)**		**CLA – 3 (10%)**		**CLA – 4 (10%)**			
		Theory	**Other Assessment**	**Theory**	**Other Assessment**	**Theory**	**Other Assessment**	**Theory**	**Other Assessment**	**Theory**	**Other Assessment**
Level 1	Remember	**50%**	**50%**	**50%**	**50%**	**30%**	**30%**	**30%**	**30%**	**30%**	-
	Understand										-
Level 2	Apply	**50%**	**50%**	**50%**	**50%**	**40%**	**40%**	**40%**	**40%**	**40%**	-
	Analyze										-
	Evaluate	-	-	-	-	**30%**	**30%**	**30%**	**30%**	**30%**	-

Learning Assessment											
	Bloom's Level of Thinking	**Continuous Learning Assessment (40% weightage)**								**Final Examination (60% weightage)**	
		CLA – 1 (10%)		**CLA – 2 (10%)**		**CLA – 3 (10%)**		**CLA – 4 (10%)**			
		Theory	**Other Assessment**	**Theory**	**Other Assessment**	**Theory**	**Other Assessment**	**Theory**	**Other Assessment**	**Theory**	**Other Assessment**
Level 1	Remember	**50%**	**50%**	**50%**	**50%**	**30%**	**30%**	**30%**	**30%**	**30%**	-
	Understand										-
Level 3	Create	-	-	-	-						-
		100%		**100%**		**100%**		**100%**		**100%**	-

Course Designers		
Experts from Industry: Name, Designation with official mail id	Experts from Higher Education Institutions: Name, Designation with official mail id	Internal Experts: Name, Designation with official id
Name: Dr. Jagdish Chandra Saraswatula *Designation : Director of Product Management, Brooks Automation, Germany* ***Email: Jagdish.saraswatula@gmail.com***	*Name: Prof. Prem Pal* *Designation: Professor, Indian Institute of Technology, Hyderabad.* *Email: prem@iith.ac.in*	*Name: Dr. Nishal Rai* *Designation: Assistant professor, SRM University Sikkim* ***Email:nishalrai.g@srmus.edu.in***

Course Code	*PHY23CO63*	**Course Name**	*Nanoscience*	**Course Category**	*C*	*Core*	L	T	P	C
							3	1	0	4
Pre-requisite			None							

. Consistency of PO with Program Learning Outcomes (PLO)	
	Program Learning Outcomes (PLO)

	1.	2.	3.	4.	5	6.	7.	8.	9.	10.	11.
	Domain Specific Knowledge	Critical Thinking and Problem Solving	Inter and Multi-disciplinary Skills	Lifelong learning	Research Aptitude	Creativity	Communication Skills	Innovation and Entrepreneurship	Vocational and Industry Exposure	Environmental awareness and sustainability	Innovation and Entrepreneurship
PO - 1	H	H	H	H	H	H	M	M	H	M	M
PO - 2	H	H	H	H	H	H	M	M	H	M	M
PO - 3	H	H	H	H	H	M	M	M	H	M	M
PO - 4	H	H	H	H	H	H	H	H	H	M	H
PO - 5	M	H	M	H	H	M	H	M	H	H	H
PO - 6	H	H	H	H	H	M	H	H	M	H	H

H – High Correlation, M – Medium Correlation, L – Low Correlation

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	**Bloom's Learning (BL) Level**	**Program Learning Outcomes (PLO)**										
			PLO-1	**PLO-2**	**PLO-3**	**PLO-4**	**PLO-5**	**PLO-6**	**PLO-7**	**PLO-8**	**PLO-9**	**PLO-10**	**PLO-11**
			Domain Specific Knowledge	Critical Thinking and Problem Solving	Inter and Multi-disciplinary Skills	Lifelong learning	Research Aptitude	Creativity	Communication Skills	Innovation and Entrepreneurship	Vocational and Industry Exposure	Environmental awareness and sustainability	Ethics
CLO-1	Acquire basic concepts of nanoscience	3	H	H	H	M	H	M	-	M	-	M	H
CLO-2	Explore the field of nanomaterials	3	H	H	H	H	H	M	-	M	-	H	H
CLO-3	Familiarize with synthesis of nanomaterials	4	H	H	H	M	H	M	-	M	-	H	M
CLO-4	Acquire basic knowledge about the characterization of nanomaterials	4	H	H	M	H	M	M	-	-	M	H	H
CLO-	Familiarize with	5	H	H	H	M	H	H	-	H	-	H	M

5	the principles and applications of nanotechnology												

(Level of correlation: ***3-High, 2-Medium, 1-Low*** can be used)

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
Unit 1	**BASICS OF NANOSCIENCE** Nano revolution of the 20th century – Difference between bulk and nanoscale materials and their significance – Properties at the nanoscale – Optical property – Magnetic property and electronic property – Size dependent behavior – Scaling – Mechanical properties of Nano materials and Chemical properties of Nanoparticles.	12	CLO1
Unit 2	**CLASSES OF NANOMATERIALS** Metals and Semiconductor Nanomaterials – Quantum dots – Nano wells – Nano ribbons and Nano Wires – Bucky balls – Carbon nanotubes – Single walled and Multi walled CNT–Structure – Synthesis– Properties– Functionalization and applications – Fullerenes/Bucky Balls/ C60– Synthesis – Properties – Functionalization and application	12	CLO2, CLO1
Unit 3	**SYNTHESIS OF NANOMATERIALS** Top–down approach – Nanolithography – Soft lithography and hard lithography – Physical Vapor deposition (PVD) – Chemical Vapor Deposition(CVD) – E–beam lithography – Bottom–up approach– Sol–gel processing and chemical methods – Self assembly.	12	CLO3, CLO2
Unit 4	**CHARACTERIZATION OF NANOMATERIALS** Scanning Electron Microscope (SEM) – Transmission Electron Microscope (TEM) – Atomic Force Microscope (AFM) – Scanning Tunneling Microscopy (STM) – Types– Manipulating atoms and Molecules with STM – Scanning Tunneling Spectroscopy and Dip pen Nanolithography.	12	CLO4, CLO3, CLO2
Unit 5	**APPLICATIONS OF NANOTECHNOLOGY** Nanotechnology in Energy systems – Electronics – Environment – Space and Aviation – Textiles – Food and Agriculture – Automotive Industry – Solar Technology – Chemical engineering – Building and Construction – Biotech and Biomedical Engineering – Pharmaceutical	12	CLO5, CLO4, CLO3, CLO2

	and drugs – Molecular Nanoelectronics		

Learning Resources	
Text Books	1. C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.) 2. K.K. Chattopadhyay and A. N. Banerjee, Introduction to Nanoscience and Technology (PHI Learning Private Limited).
Ref. Books	1. S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publishing Company) 2. Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons). 3. M. Hosokawa, K. Nogi, M. Naita, T. Yokoyama, Nanoparticle Technology Handbook (Elsevier, 2007) 4. Bharat Bhushan, Springer Handbook of Nanotechnology (Springer-Verlag, Berlin, 2004).

Learning Assessment											
	Bloom's Level of Thinking	**Continuous Learning Assessment (40% weightage)**								**Final Examination (60% weightage)**	
		CLA – 1 (10%)		**CLA – 2 (10%)**		**CLA – 3 (10%)**		**CLA – 4 (10%)**			
		Theory	**Other Assessment**	**Theory**	**Other Assessment**	**Theory**	**Other Assessment**	**Theory**	**Other Assessment**	**Theory**	**Other Assessment**
Level 1	Remember	**50%**	**50%**	**50%**	**50%**	**30%**	**30%**	**30%**	**30%**	**30%**	-
	Understand										-
Level 2	Apply	**50%**	**50%**	**50%**	**50%**	**40%**	**40%**	**40%**	**40%**	**40%**	-
	Analyze										-

Learning Assessment											
	Bloom's Level of Thinking	**Continuous Learning Assessment (40% weightage)**								**Final Examination (60% weightage)**	
		CLA – 1 (10%)		**CLA – 2 (10%)**		**CLA – 3 (10%)**		**CLA – 4 (10%)**			
		Theory	**Other Assessment**	**Theory**	**Other Assessment**	**Theory**	**Other Assessment**	**Theory**	**Other Assessment**	**Theory**	**Other Assessment**
Level 1	Remember	**50%**	**50%**	**50%**	**50%**	**30%**	**30%**	**30%**	**30%**	**30%**	-
	Understand										-
Level 3	Evaluate	-	-	-	-	**30%**	**30%**	**30%**	**30%**	**30%**	-
	Create	-	-	-	-						-
		100%		**100%**		**100%**		**100%**		**100%**	-

Course Designers		
Experts from Industry: Name, Designation with official mail id	Experts from Higher Education Institutions: Name, Designation with official mail id	Internal Experts: Name, Designation with official id
Name: Dr. Jagdish Chandra Saraswatula *Designation : Director of Product Management, Brooks Automation, Germany* ***Email: Jagdish.saraswatula@gmail.com***	*Name: Prof. Prem Pal* *Designation: Professor, Indian Institute of Technology, Hyderabad.* *Email: prem@iith.ac.in*	*Name: Dr. Nishal Rai* *Designation: Assistant professor, SRM University Sikkim* ***Email:nishalrai.g@srmus.edu.in***

Course Code	*PHY23MI51*	**Course Name**	*Concepts Of Nuclear & Particle Physics*	**Course Category**	*M*	*Minor*	L	T	P	C
							3	1	0	4
Pre-requisite			None							

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO-1	**PLO-2**	**PLO-3**	**PLO-4**	**PLO-5**	**PLO-6**	**PLO-7**	**PLO-8**	**PLO-9**	**PLO-10**	**PLO-11**
			Domain Specific Knowledge	Critical Thinking and Problem Solving	Inter and Multi-disciplinary Skills	Lifelong learning	Research Aptitude	Creativity	Communication Skills	Innovation and Entrepreneurship	Vocational and Industry Exposure	Environmental awareness and sustainability	Ethics
CLO-1	Comprehend the basic characteristics of the nucleus and nuclear properties	3	H	H	H	M	H	M	-	M	-	M	H
CLO-2	Comprehend the concepts of various nuclear models	4	H	H	H	H	H	M	-	M	-	H	H
CLO-3	Acquaint with the different modes of decay and interaction of nuclear radiations with matter	4	H	H	H	M	H	M	-	M	-	H	M
CLO-4	Comprehend with basics the principles of acceleraterators and nuclear detectors	4	H	H	M	H	M	M	-	-	M	H	H
CLO-5	Comprehend the basic interaction between fundamental particles	4	H	H	H	M	H	H	-	H	-	H	M

(Level of correlation: ***3-High, 2-Medium, 1-Low*** can be used)

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
Unit 1	**Nuclear Properties** Constituents of nucleus and their Intrinsic properties – quantitative facts about size – mass – charge density (matter energy) – binding energy (B.E.) – average binding energy and its variation with mass number – main features of B.E. vs Mass Number curve – Neutrons vs Nucleons plot – angular momentum – parity – magnetic moment – electric moments.	12	CLO1
Unit 2	**Nuclear Models** Properties of nuclear forces and saturation – Non–existence of electrons in the nucleus and neutron proton model – Assumptions of liquid drop model – semi–empirical mass formula – conditions of nuclear stability – Nuclear Shell Model – Experimental evidence of magic numbers and its explanation.	12	CLO1, CLO2
Unit 3	**Nuclear Processes** Radioactivity: Alpha emission – qualitative discussion of alpha spectra – Geiger–Nuttal rule – Beta emission – qualitative discussion of beta spectra–positron emission – electron capture – Neutrino hypothesis of beta decay – Evidence of existence of Neutrino – gamma–ray emission – qualitative discussion of gamma–ray spectra – internal conversion. Interaction with Matter: Energy loss due to ionization (Bethe–Bloch formula) – Energy loss of electrons – Gamma–ray through matter – pair production– radiation loss by fast electrons – electron–positron annihilation. Reactions: Conservation principles in nuclear reactions – Q–values and thresholds– nuclear reaction cross–sections – examples of different types of reactions and their characteristics– Bohr's postulate of compound nuclear reaction.	12	CLO3
Unit 4	**Acceleration and Detection** Accelerators: Cyclotron – Van–de–graaff generator – Qualitative discussion of Synchrotron – Linear accelerators.Detectors: Ionization chamber – G.M. counter – Basic principle of Scintillation Detectors and construction of photo–multiplier tube (PMT) – SemiconductoElementary particles and their classification	12	CLO3, CLO4

	– types of fundamental interactions – Conservation laws and quantum numbers – concepts of isospin – strangeness – charge conjugation – antiparticles– introduction to quarks – leptons – hadrons – qualitative discussion of the quark model. r Detectors (Si and Ge) for charge particle and photon detection.		
Unit 5	**Introduction of Elementary Particles** Elementary particles and their classification – types of fundamental interactions – Conservation laws and quantum numbers – concepts of isospin – strangeness – charge conjugation – antiparticles– introduction to quarks – leptons – hadrons – qualitative discussion of the quark model.	12	, CLO5

Learning Resources	
Text Books	1. Mittal, V.K., Verma R.C. and Gupta S.C, *Introduction to Nuclear and Particle Physics,* PHI Learning, 3rd Edition, 2013 2. Kaplan, I.,*Nuclear Physics*, Narosa Publishers, 2002. 3. Ghoshal S.N.,*Nuclear Physics,* S. Chand, 2nd Edition, 1994.
Ref. Books	1. Segre E., *Nuclei & Particles,* W.A. Benjamin Inc., 1965. 2. Krane K. S., *Introductory Nuclear Physics,* John–Wiley, 1987. 3. Cohen, B.L., *Concepts of Nuclear Physics,* TMH Edition, 1971. 4. Verma, J.,*Fundamentals of Nuclear Physics,* CBS, 2013

Learning Assessment											
	Bloom's Level of Thinking	**Continuous Learning Assessment (40% weightage)**								**Final Examination (60% weightage)**	
		CLA – 1 (10%)		**CLA – 2 (10%)**		**CLA – 3 (10%)**		**CLA – 4 (10%)**			
		Theory	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**
Level 1	Remember	**50%**	**50%**	**50%**	**50%**	**30%**	**30%**	**30%**	**30%**	**30%**	-
	Understand										-
Level 2	Apply	**50%**	**50%**	**50%**	**50%**	**40%**	**40%**	**40%**	**40%**	**40%**	-
	Analyze										-

Learning Assessment											
	Bloom's Level of Thinking	**Continuous Learning Assessment (40% weightage)**								**Final Examination (60% weightage)**	
		CLA – 1 (10%)		**CLA – 2 (10%)**		**CLA – 3 (10%)**		**CLA – 4 (10%)**			
		Theory	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**
Level 1	Remember	**50%**	**50%**	**50%**	**50%**	**30%**	**30%**	**30%**	**30%**	**30%**	-
	Understand										-
Level 3	Evaluate	-	-	-	-	**30%**	**30%**	**30%**	**30%**	**30%**	-
	Create	-	-	-	-						-
		100%		**100%**		**100%**		**100%**		**100%**	-

Course Designers		
Experts from Industry: Name, Designation with official mail id	Experts from Higher Education Institutions: Name, Designation with official mail id	Internal Experts: Name, Designation with official id
Name: Dr. Jagdish Chandra Saraswatula *Designation : Director of Product Management, Brooks Automation, Germany* ***Email: Jagdish.saraswatula@gmail.com***	*Name: Prof. Prem Pal* *Designation: Professor, Indian Institute of Technology, Hyderabad.* *Email: prem@iith.ac.in*	*Name: Dr. Nishal Rai* *Designation: Assistant professor, SRM University Sikkim* ***Email:nishalrai.g@srmus.edu.in***

Course Code	*PHY1865*	**Course Name**	*Core Based Project*	**Course Category**	*P*	*PROJECT*	L	T	P	C
							0	0	8	4
Pre-requisite - NIL				**Co-requisite NIL**						

Semester VII

Course Code	UNI23RP72	Course Name	Data Analytics & Statistical Applications	Course Category		*Core*	L	T	P	C
							2	0	4	4
Pre-requisite				**Co-requisite**						

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	**Bloom's Learning (BL) Level**	**Program Learning Outcomes (PLO)**										
			PLO 1	**PLO 2**	**PLO 3**	**PLO 4**	**PLO 5**	**PLO 6**	**PLO 7**	**PLO 8**	**PLO 9**	**PLO10**	**PLO11**
			Domain Specific Knowledge	Critical Thinking and Problem Solving	Inter and Multi-disciplinary Skills	Lifelong learning	Research Aptitude	Creativity	Communication Skills	Innovation and Entrepreneurship	Vocational and Industry Exposure	Environmental awareness and sustainability	Ethics
CLO-1	Understand the data and importance of data in decision making	1	H	H	H	H	H	-	-	M	M	-	H
CLO-2	Express the knowledge on how to use measures of dispersion	2	H	H	H	H	H	-	-	M	M	-	H
CLO-3	Apply the knowledge and use of correlation and regression analysis	3	H	H	H	H	H	-	-	M	M	-	H
CLO-4	Understand about the probability and probability distribution	4	H	H	H	-	H	M	-	-	M	-	H
CLO-5	Apply the inferential statistics for estimation.	5	H	H	H	H	H	-	-	M	M	-	H

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
1	**Unit I: INTRODUCTION TO STATISTICAL DATA & SOFTWARE:** Data: Meaning and importance, Types of data in research, scale of measurement, continuity, origin, characteristics; Scope of data, Data Structure – Cross Sections, Time Series, and Panel Data; Data Size - High Frequency and Big Data Sets; Data Generating	12	**CLO1**

	Process (DGP).		
2	**Unit II: DESCRIPTIVE STATISTICS-** Measures of central tendency- Mean, Median, Mode, combined mean, weighted average, Quartiles, Deciles and Percentiles Measures of variation - Range, Quartile Deviation, Standard deviation, Coefficients, Variance and Coefficient of variation.	12	**CLO2**
3	**Unit III: INFERENTIAL STATISTICS (PARAMETRIC TEST)-** Parametric Test: Student T- test, Z- test (testing of single mean and testing of two population means), ANOVA TEST- One-way ANOVA, Two-way ANOVA, Correlation analysis – scatter diagram method.	12	**CLO3**
4	**Unit IV: INFERENTIAL STATISTICS (NON-PARAMETRIC TEST)-** Non-Parametric Tests- Meaning and importance, Chi-square test- Goodness of fit and Independence of attributes, U-test, H test and K-S test.	12	**CLO4**
5	**Unit V: MODEL ESTIMATION-** Estimation of Regression Model; Testing and Interpretation of Regression coefficients; Testing of Hypotheses and their interpretation; Functional Forms; Dummy Variables., Multicollinearity, Heteroscedasticity, Autocorrelation; Simultaneous-Equations Models; Identification & Estimation**.**	12	**CLO5**

Learning Resources	
Text Books	1. S. P. Gupta, "Statistical Methods", Sultan Chand & Sons; 1ST edition, 2014. 2. Levine, Stephan, Krehbiel and Berenson, "Statistics for Managers using Microsoft Excel", PHI Learning Private Limited, 2010.
Ref. Books	1. Gerald Keller, "Managerial Statistics", Cengage Learning, 2011. 2. Arora P.N., "Managerial Statistics", S.Chand Limited, 2009. 3. Dr. T.N. Srivastava, Statistics for Management, Tata McGraw Hill Publishing Company, 2008. 4. N G Das, "Statistical Methods", Volume – 1 and Volume 2, McGraw Hill Education; 1st Edition, 2008. 5. Dr. Deepak Chawla, Dr. Neena Sondhi, "Research Methodology Concepts and Cases", Vikas Publishing House Private Limited, 2011. 6. Vikram Dayal, An Introduction to R for Quantitative Economics: Graphing, Simulating and Computing, Springer Briefs in Economics, Springer (India), 2015.

Bloom's Level of Thinking		**Continuous Internal Assessment (40% weightage)**										**Final Examination (60 % weightage)**	
		CIA- 1		**CIA- 2**		**CLA – 3**		**CLA – 4**		**CLA – 5**			
		Theory	**Practice**	**Theory**	**Practice**	**Theory**	**Practice**	**Theory**	**Practice**	**Theory**	**Practice**	**Theory**	**Practice**
1	Remember	***30%***		***20%***		***20%***		***30%***		***10%***		***30%***	
2	Understand	***30%***		***20%***		***20%***		***30%***		***10%***		***20%***	
3	Apply	***10%***		***30%***		***30%***		***20%***		***20%***		***20%***	
4	Analyse	***30%***		***20%***		***20%***		***20%***		***20%***		***10%***	
5	Evaluate	-		***10%***		-				***20%***		***10%***	
6	Create	-		-		***30%***				***20%***		***10%***	
	Total	**100%**		**100%**		**100%**		**100%**				**100%**	

Course Designers		
Experts from Industry: Name, Designation with official mail id	Experts from Higher Education Institutions: Name, Designation with official mail id	Internal Experts: Name, Designation with official id
	Dr. Komal Singha	***Dr. Praveen Rizal***

	Professor, Department of Economics Sikkim Central University, Sikkim *Email id:* *ksingha@cus.ac.in*	*Associate Professor* *Department of Economics* *SRM University Sikkim* *praveen.r@srmus.edu.in*

Course Code		**Course Name**	**Research Methodology**	**Course Category**		**CORE COURSE**	**L**	**T**	**P**	**C**
							3	**0**	**2**	**4**
Pre-requisite				**Co-requisite**						

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	**Blooms Learning (BL) Level**
CLO-1	Understand the methods of research design	**2**
CLO-2	Apply Data collection and analysis tools in research	**3**
CLO-3	Analyze sample data	**4**
CLO-4	Evaluate different methods and tools in qualitative research	**5**
CLO-5	Create research-proposals, research-reports, presentations and manuscripts for publication.	**6**

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	**Bloom's Learning (BL) Level**	**Program Learning Outcomes (PLO)**										
			PLO 1	**PLO 2**	**PLO 3**	**PLO 4**	**PLO 5**	**PLO 6**	**PLO 7**	**PLO 8**	**PLO 9**	**PLO10**	**PLO11**
			Domain Specific Knowledge	Critical Thinking and Problem Solving	Inter and Multi-disciplinary Skills	Lifelong learning	Research Aptitude	Creativity	Communication Skills	Innovation and Entrepreneurship	Vocational and Industry Exposure	Environmental awareness and sustainability	Ethics
CLO-1	Understand the methods of research design	2	H	M	H	H	H	H	H	M	M	-	H
CLO-2	Apply Data collection and analysis tools in research	3	H	M	H	H	H	H	H	M	M	-	H

CLO-3	Analyze sample data	4	H	H	H	H	H	H	H	M	M	-	H
CLO-4	Evaluate different methods and tools in qualitative research	5	H	M	H	-	H	H	H	-	H	-	H
CLO-5	Create research-proposals, research-reports, presentations and manuscripts for publication.	6	H	H	H	H	H	H	H	M	H	-	H

Summary of Course Content			
Sr. No	**Course Content**	**Hour**	**Alignment to CLO**
Unit I	**Research Design** Objectives of research- type of research – understanding research and its goals, critical thinking, selecting topic for research, justification and rationale development, research designs, method of scientific enquiry, formulation of hypothesis, writing a research proposal - Ethics of research planning and preparation Practical: Topic selection through literature review, Proposal writing, Journal club	12	CLO 1
Unit II	**Data collection, analysis and inference** Questionnaire design, selection of samples, errors in data collection, data validation process, data entry formats, data entry software, data cleaning and management, basic statistical analysis, univariate and multivariate - interpretation and discussion of research findings- Ethics in Data collection Practical: Questionnaire design for a study, Data entry, cleaning and management using software	12	CLO 2
Unit III	**Sampling and Sampling Methods** Definition of sampling, principles of sampling, advantages and disadvantages of sampling, probability and non-probability sampling methods, simple random sampling, systematic random sampling, stratified random sampling, cluster sampling, multistage sampling methods, determination of sample size, sampling weights, choosing appropriate sampling methods for research - Ethical issues in sample selection Practical: Application of sampling methods and sample selection strategies	12	CLO3

Unit IV	**Qualitative Research Methods** Introduction to qualitative research, Ethnography, Phenomenology, Narrative Enquiry, Focus Group Discussions, In depth Interviews, Recording qualitative interviews, transcription, analysis paradigms, grounded theory methodology, content analysis, discourse analysis, Reflective analysis, Qualitative data analysis software, coding, thematic analysis, conceptual diagram Practical: Qualitative data analysis software, coding, thematic analysis, conceptual diagram	12	CLO 4
Unit V	**Academic writing and presentations** Proposal writing for obtaining funding, elements of writing style, writing research reports, manuscript preparation for publication, referencing styles, oral presentations, poster presentations, peer review process, thesis writing, Ethical issues in thesis writing- Sources of information, review of literature, online databases, search tools, effective use of pubmed and other online search engines Practical: Proposal writing, Application of online databases, search tools and online databases.	12	CLO 5

Learning Resources	
Text Books	1. World Health Organization. Health Research Methodology A guide for training in research methods. -World Health Organization -World Health Organization, 2011 2. Sampling: Design and Analysis. -Sharon L Lohar. Second Edition. -Brooks / Cole Cengage Learning, 2010
Ref. Books	1. Designing Qualitative Research: An Interactive Approach. -Maxwell, J, Third Edition-Sage Publications, 2013 2. Qualitative Interviewing: The Art of Hearing Data -Rubin, H. and I. Rubin-Thousand Oaks, CA: Sage Publications. 2005 3. Research Methods in Health: Investigating Health and Health Services-Second Edition. Ann Bowling. -Open University Press, Buckingham, 2002 4. Fundamentals of Research Methodology for Health Care Professionals. -Second Edition. Hilla Brink, Christa Van der Walt, Gisela Van Rensburg. -Juta and Company Ltd, 2006 5. Writing Ethnographic Field notes. -Emerson, Robert M., Rachel I. Fretz, and Linda L. Shaw. -University of Chicago Press.1995 6. Participatory Rural Appraisal: Principles, Methods and Application. -N Narayanaswamy-Sage Publications Pvt. Ltd. 2009

Bloom's Level of Thinking		**Continuous Internal Assessment (100% weightage)**									
		CIA- 1 Assignment- I		**CIA- 2 Assignment- II**		**CLA – 3 Assignment- III**		**CLA – 4 Assignment - IV**		**CLA – 5 Final Assignment - V**	
		Theory	**Practice**	**Theory**	**Practice**	**Theory**	**Practice**	**Theory**	**Practice**	**Theory**	**Practice**
1	Remember		***30%***		***20%***		***20%***		***20%***		***20%***
2	Understand		***30%***		***20%***		***20%***		***20%***		***20%***
3	Apply		***10%***		***30%***		***30%***		***30%***		***20%***
4	Analyse		***30%***		***20%***	-					***20%***
5	Evaluate	-			***10%***	-					***10%***
6	Create	-		-			***30%***		***30%***		***10%***

	Total	100%	100%	100%	100%	100%

Course Designers		
Experts from Industry: Name, Designation with official mail id	**Experts from Higher Education Institutions: Name, Designation with official mail id**	**Internal Experts: Name, Designation with official id**
NA		Mr. Dhirendra Kumar Shah and Assistant Professor, SRM University Sikkim, dhirendrakumarshah.d@srmus.edu.in Dr. Hindol Chakraborty, Assistant Professor, SRM University Sikkim, hindol.c@srmus.edu.in

Course Code		**Course Name**	**Scientific Writing and Research Ethics**	**Course Category**		***CORE COURSE***	**L**	**T**	**P**	**C**
							3	**0**	**2**	**4**
Pre-requisite				**Co-requisite**						

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	**Bloom's Learning (BL) Level**	**Program Learning Outcomes (PLO)**										
			Domain Specific Knowledge	Critical Thinking and Problem Solving	Inter and Multi-disciplinary Skills	Life long learning	Research Aptitude	Creativity	Communication Skills	Innovation and Entrepreneurship	Vocational and Industry Exposure	Environmental awareness and sustainability	Ethics
			H	M	H	H	H	H	H	-	M	-	H
CLO-1	Demonstrate the skills for writing a Research Proposal	2	H	M	H	H	H	H	H	-	M	-	H
CLO-2	Estimate the budget requirements for a research fund application	2	H	H	H								

						H	H	H	H	H	M	-	H
CLO-3	Prepare a manuscript for publication following the guidelines.	3	H	M	H	-	H	H	H	-	M	-	H
CLO-4	Analyze and adopt an appropriate ethical stance towards writing and publication	4	H	H	H	H	H	H	H	H	M	-	H
CLO-5	Develop the skills required for writing a book	6	H	H	H	H	H	H	H		M		H
	Average												
(Level of correlation: ***3-High, 2-Medium, 1-Low*** can be used)													

Summary of Course Content			
Sr. No	**Course Content**	**Hour**	**Alignment to CLO**
Unit I	**Writing a Research Proposal:** Writing the Cover Page – Title Page, Abstract Writing the Introduction – Purpose/Relevance, Furnishing Research Question/Hypothesis, Aim and Objectives Writing Literature Review - Empirical Analyses, Theoretical Analyses, Research Gaps Writing the Methods and Design - Research Philosophy, Research Approach, Research Design, Data Collection Writing the Significance and Expected Results– Research Contribution, Potential Outcomes and Limitations Writing the Conclusion - Summarize key points and significance of research Writing the Appendices and References - Additional Data, Questionnaire, Interview Questions, citations Proofreading and Editing - Errors in Grammar and Punctuation, Revisions	12	CLO 1

Unit II	**Writing a Budget Proposal:** Research Cost – Personal Costs, Equipment and Supplies, Travel Expenses, Budget for Data Collection & Analyses, Participant Compensation, fees linked with Publication and Dissemination, Contingency Fund, Consultation Fees, Training and Development Justification on Cost Source of Expenditure Timeline and Payment Schedule Final Budget Summary	12	CLO 2
Unit III	**Manuscript Writing:** Understanding the Publication Process Selecting a Target Journal Writing according to the Authors Guidelines Title and Abstract Writing Introduction and Literature Review Writing the Methods and Results Presentation Writing the Discussion section and Conclusion– Interpret Findings, Implications, Limitations, and Future Research, Summarize key findings and their significance Citation and Referencing – Citing sources following a specific citation style Manuscript formatting – font, spacing and margin specifications Submission Process Preparing a Cover Letter – writing a letter to the Editor Peer Review Process Responding to Reviewers Comments	12	CLO3
Unit IV	**Publication Ethics** Role of ethical behavior in scholarly publishing Criteria for Authorship and Acknowledging Contributors Plagiarism and Self-Plagiarism – Data Fabrication and falsification, Redundant or Duplicate Publication, Salami Slicing, Image Manipulation, Publication Bias and its impact on Research Research Misconducts and Research Integrity Conflict of Interest Peer Review Ethics Ethical use of Human and Animal Subjects Ethical approval - Consent Letter, Code of Ethics Open Access and Copyright Predatory Journals and Conferences Journal Selection and Impact Factor	12	CLO 4
Unit V	**Introduction to Book Writing** Overview of the Book Writing Process Choosing a Compelling Book Topic – Researching market demand and competition Creating a structured book outline – outlining chapters and subtopics Research and Fact-Checking Setting Writing Goals Writing Style and Voice	12	CLO 5

	Drafting the manuscript Editing and Revising Title and Cover Design Considerations Publishing the Book - Conventional /Self-Publishing, Marketing and Promotion, Legal and Copyright Issues, Author Branding, Book Launch and Beyond		

Learning Resources	
Text Books	• Chowdhary, Nimit, Hussain Sarah. *Handbook of Research and Publication Ethics*. Bharti Publication, 2021. • Hofmann, Angelika H. *Scientific Writing and Communication: Papers, Proposals, and Presentations*. Oxford UP, USA, 2017. • Katz, Michael J. *From Research to Manuscript: A Guide to Scientific Writing*. 2006, ci.nii.ac.jp/ncid/BB01221094. • Lalli, William R. *Handbook of Budgeting*. John Wiley and Sons, 2012.
Ref. Books	• Becker, Howard S. *Writing for Social Scientists: How to Start and Finish Your Thesis, Book, or Article*: Second Edition. University of Chicago Press, 2007. • D, Andrea R. Gwosdow Ph. *The Complete Guide to Scientific Manuscript Writing*. Aviva Publishing, 2018. • Hayot, Eric. *The Elements of Academic Style: Writing for the Humanities*. Columbia UP, 2014. • Labaree RV. *Organizing Your Social Sciences Research Paper: Writing a Research Proposal*. Available from: http://www.libguides.usc.edu/writingguide. • Lerner, Betsy. *The Forest for the Trees (Revised and Updated): An Editor's Advice to Writers*. National Geographic Books, 2010. • *The Writer's Options: Lessons in Style and Arrangement* (8th ed.) by Max Morenberg and Jeff Sommers. • McGranaghan M. Guidelines on Writing a Research Proposal. Available from: https://www.2.hawaii.edu/~matt/proposal.html • Booth, Wayne C., et al. The Craft of Research. University of Chicago Press, 2016.

Bloom's Level of Thinking		**Continuous Internal Assessment (100% weightage)**									
		CIA- 1 Assignment- I		**CIA- 2 Assignment- II**		**CLA – 3 Assignment- III**		**CLA – 4 Assignment - IV**		**CLA – 5 Final Assignment - V**	
		Theory	**Practice**	**Theory**	**Practice**	**Theory**	**Practice**	**Theory**	**Practice**	**Theory**	**Practice**
1	Remember		***30%***		***20%***		***20%***		***20%***		***20%***
2	Understand		***30%***		***20%***		***20%***		***20%***		***20%***
3	Apply		***10%***		***30%***		***30%***		***30%***		***20%***
4	Analyse		***30%***		***20%***	-					***20%***
5	Evaluate	-			***10%***	-					***10%***
6	Create	-		-			***30%***		***30%***		***10%***
	Total	**100%**		**100%**		**100%**		**100%**		**100%**	

Assignments will be conducted for 10 marks each.
The final Assignment will be conducted for 60 marks, to be reviewed by experts.

Course Designers		
Experts from Industry: Name, Designation with official mail id	**Experts from Higher Education Institutions: Name, Designation with official mail id**	**Internal Experts: Name, Designation with official id**
NA		Mr. Dhirendra Kumar Shah and Assistant Professor, SRM University Sikkim, dhirendrakumarshah.d@srmus.edu.in Dr. Hindol Chakraborty, Assistant Professor, SRM University Sikkim, hindol.c@srmus.edu.in

Semester VIII

Course Code	UNI23 RP81	**Course Name**	Research Project	**Course Category**			**L**	**T**	**P**	**C**
							0	**0**	**0**	**12**
Pre-requisite				**Co-requisite**						

Course Code	UNI23 RP82	**Course Name**	Presentation and Viva Voce	**Course Category**			**L**	**T**	**P**	**C**
							0	**0**	**0**	**4**
Pre-requisite				**Co-requisite**						

Course Code	UNI23 RP83	**Course Name**	Research Paper and Dissertation	**Course Category**			**L**	**T**	**P**	**C**
							0	**0**	**0**	**4**
Pre-requisite				**Co-requisite**						

MINOR IN MATHEMATICS AND COMPUTATION

SEMESTER I

Course Code	**MAA23MI11**	**Course Name**	**Basic Algebra**	**Course Category**	*MI*	*MINOR*	L	T	P	C
							2	1	0	3
Pre-requisite			None							

Cours	*At the end of*	**Bloo**	**Program Learning Outcomes (PLO)**

e Learning Outcomes (CLO)	this course, learners will be able to:	m's Learning (BL) Level	PLO-1	PLO-2	PLO-3	PLO-4	PLO-5	PLO-6	PLO-7	PLO-8	PLO-9	PLO-10	PLO-11
			Domain Specific Knowledge	Critical Thinking and Problem Solving	Inter and Multidisciplinary Skills	Lifelong learning	Research Aptitude	Creativity	Communication Skills	Innovation and Entrepreneurship	Vocational and Industry Exposure	Environmental awareness and sustainability	Ethics
CLO-1	Define basic concepts for clear understanding of mathematical principles like set theory.	2	H	H	M	M	H	M	-	M	-	M	M
CLO-2	Demonstrate the ideas of Number theory.	3	H	M	H	H	H	M	-	M	-	H	M
CLO-3	Apply different Numerical Methods to solve different types of equations.	3	H	H	H	M	M	M	-	M	-	H	M
CLO-4	Analyze Problems dealing with matrices.	3	H	M	M	H	M	M	-	-	M	H	H
CLO-5	Explain the concepts of Vectors.	3	H	H	M	M	H	H	-	H	-	H	M

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
Unit 1	**SETS, RELATIONS AND FUNCTIONS** Sets- representation of sets- Types of sets- Operation on sets-De Morgan's law- Venn diagram. Relation- Types of relation Equivalence Relation. Function- types of Functions-Composite o	9	CLO1

	two functions- graph of linear, trigonometric, exponential and logarithmic functions.		
Unit 2	**NUMBER THEORY FUNDAMENTALS** Well ordering property of positive integers - Division algorithm - Divisibility & Euclidean algorithm - Congruence relation between integers - Statement of the Fundamental Theorem of Arithmetic.	9	CLO2
Unit 3	**THEORY OF EQUATIONS** Polynomial equations- Irrational roots- Complex roots- (up to third order equations only) - Approximation of roots of a polynomial equation by Newton's methods, secant method.	9	CLO3
Unit 4	**MATRICES** Symmetric - Skew symmetric- Hermitian- Skew Hermitian- Orthogonal-Unitary matrices – Cayley Hamilton Theorem –Eigen values– Eigen vectors (for 2*2 matrix only)– Solving the equations using Cramer's rule computing rank of matrices by reducing them to echelon's Form-Rank and consistency of linear equation	9	CLO4
Unit 5	**VECTORS** Introduction-parallelogram law of vectors-dot product projection of a vector-cross product-triple cross product - directional derivatives-divergence-curl.	9	CLO5

Learning Resources	
Text Books	1. Shanti Narayan, P.K. Mittal, A Textbook of Matrices,2004, S Chand & Co Ltd 2. N.P. Bali, Manish Goyal, A Textbook of Engineering Mathematics, 2014, Laxmi Publication Private limited 3. A TEXTBOOK OF VECTOR CALCULUS, 4th Revised Edition, S Chand publication. 4. Elementary Number Theory , David M.Burton
Ref. Books	1. Hall and Knight, Higher Algebra (Old Edition) Paperback.

Learning Assessment											
	Bloom's Level of Thinking	**Continuous Learning Assessment (40% weightage)**								**Final Examination (60% weightage)**	
		CLA – 1 (10%)		**CLA – 2 (10%)**		**CLA – 3 (10%)**		**CLA – 4 (10%)**			
		Theory	**Other Assessment**	**Theory**	**Other Assessment**	**Theory**	**Other Assessment**	**Theory**	**Other Assessment**	**Theory**	**Other Assessment**
Level 1	Remember	**50%**	**50%**	**50%**	**50%**	**30%**	**30%**	**30%**	**30%**	**30%**	-
	Understand										-
Level 2	Apply	**50%**	**50%**	**50%**	**50%**	**40%**	**40%**	**40%**	**40%**	**40%**	-
	Analyze										-
Level 3	Evaluate	-	-	-	-	**30%**	**30%**	**30%**	**30%**	**30%**	-
	Create	-	-	-	-						-
		100%		**100%**		**100%**		**100%**		**100%**	-

Course Designers		
Experts from Industry: Name, Designation with official mail id	Experts from Higher Education Institutions: Name, Designation with official mail id	Internal Experts: Name, Designation with official id
Name: Dr. Jagdish Chandra Saraswatula *Designation : Director of Product Management, Brooks Automation, Germany* ***Email: Jagdish.saraswatula@gmail.com***	*Name: Prof. Prem Pal* *Designation: Professor, Indian Institute of Technology, Hyderabad.* *Email: prem@iith.ac.in*	*Name: Bikash Thakuri* *Designation: Assistant Professor, SRM University Sikkim* ***Email: bikashthakuri.p@srm***

SEMESTER – II

Course Code	MAA23MI21	Course Name	Computational Calculus	Course Category	*MI*	*MINOR*	L	T	P	C
							2	0	2	3
Pre-requisite			None							

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	**Bloom's Learning (BL) Level**	**Program Learning Outcomes (PLO)**										
			PLO-1	**PLO-2**	**PLO-3**	**PLO-4**	**PLO-5**	**PLO-6**	**PLO-7**	**PLO-8**	**PLO-9**	**PLO-10**	**PLO-11**
			Domain Specific Knowledge	Critical Thinking and Problem Solving	Inter and Multidisciplinary Skills	Lifelong learning	Research Aptitude	Creativity	Communication Skills	Innovation and Entrepreneurship	Vocational and Industry Exposure	Environmental awareness and sustainability	Ethics
CLO-1	Relate the notion of limits, continuity and derivative of functions.	2	H	H	M	H	H	M	-	M	-	M	H
CLO-2	Demonstrate Geometrical properties of continuous functions on closed and bounded intervals	3	H	H	M	H	H	M	-	M	-	M	M
CLO-3	Apply the principles of differentiation to solve a variety of practical	3	H	H	M	M	H	M	-	M	-	H	M

	problems in science.												
CLO-4	Analyze wide ranging application of the Integral calculus.	3	H	H	M	H	M	M	-	-	M	M	H
CLO-5	Compare Proper and Improper Integrals.	3	H	H	H	M	M	H	-	H	-	M	M

(Level of correlation: ***3-High, 2-Medium, 1-Low*** can be used)

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
Unit 1	**CONTINUITY AND DIFFERENTIABILITY OF FUNCTION** Limits and continuity-Types of discontinuities. Differentiability of functions-Successive differentiation-Calculation of the nth derivatives-Leibnitz theorem. Partial differentiation-Euler's theorem on homogeneous functions.	6	CLO1
Unit 2	**MEAN VALUE THEOREMS AND ITS APPLICATIONS** Rolle's theorem, Mean value theorems and applications to monotonic functions and inequalities. Expansion of functions- Taylor's theorem-Taylor's series- Maclaurin's series - expansion of e^x, sin x, cos x , log(1 + x) and $(1 + x)^m$. Indeterminate forms.	6	CLO2
Unit 3	**TANGENTS AND NORMAL** Maxima and Minima (for functions of two variables)-Tangents and Normals (polar form only)-Curvature-Envelopes and Evolutes.	6	CLO3
Unit 4	**INTEGRAL CALCULUS** Simple problems only-integration by substitution-partial fraction-product rule- integration of simple functions- definite integral – application of definite integral in evaluating area under a curve-double integral.	6	CLO4
Unit 5	**IMPROPER INTEGRAL**	6	CLO5

	Improper Integrals-classification and conversions. comparison Test,μ- test, Abel's test, Dirichlet's test.		

Additional 30 hours for Practical

PRACTICAL/LAB WORK TO BE PERFORMED ON A COMPUTER (30 Hours)

Use of computer aided software (CAS), for example Matlab / Mathematica / Maple / Maxima etc., for developing the following Numerical programs:

- Introduction to the software and commands related to the topic.
- Computation of addition and subtraction of matrices
- Computation of Multiplication of matrices.
- Computation of Trace and Transpose of Matrix
- Computation of Inverse of a Matrix using Cayley-Hamilton theorem.
- Solving the system of homogeneous and non-homogeneous linear equations.
- Finding the nth Derivative of algebraic exponential trigonometric and hyperbolic functions

Learning Resources	
Text Books	1. Gorakh Prasad, A text book of Differential Calculus, Pothishala Private Ltd., Prayagraj. 2. Gorakh Prasad, A text book of Integral Calculus, Pothishala Private Ltd., Prayagraj. 3. B.S. Grewal, Higher Engineering Mathematics, Khana Publisher.
Ref. Books	1. Erwin Kreyszig, *Advanced Engineering Mathematics*, 10th Edition, Willey 2011. 2. Calculus - Single and Multivariable by Hughes-Hallett

Learning Assessment											
	Bloom's Level of Thinking	**Continuous Learning Assessment (40% weightage)**								**Final Examination (60% weightage)**	
		CLA – 1 (10%)		**CLA – 2 (10%)**		**CLA – 3 (10%)**		**CLA – 4 (10%)**			
		Theory	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**
Level 1	Remember	**50%**	**50%**	**50%**	**50%**	**30%**	**30%**	**30%**	**30%**	**30%**	-
	Understand										-
Level 2	Apply	**50%**	**50%**	**50%**	**50%**	**40%**	**40%**	**40%**	**40%**	**40%**	-
	Analyze										-
Level 3	Evaluate	-	-	-	-	**30%**	**30%**	**30%**	**30%**	**30%**	-
	Create	-	-	-	-						-
		100%		**100%**		**100%**		**100%**		**100%**	-

Course Designers		
Experts from Industry: Name, Designation with official mail id	Experts from Higher Education Institutions: Name, Designation with official mail id	Internal Experts: Name, Designation with official id
Name: Dr. Jagdish Chandra Saraswatula *Designation : Director of Product Management, Brooks Automation, Germany* ***Email: Jagdish.saraswatula@gmail.com***	*Name: Prof. Prem Pal* *Designation: Professor, Indian Institute of Technology, Hyderabad.* *Email: prem@iith.ac.in*	*Name: Bikash Thakuri* *Designation: Assistant Professor, SRM University Sikkim* ***Email: bikashthakuri.p@srm***

SEMESTER – III

Course Code	MAA23MI31	Course Name	Group Theory	Course Category	*MI*	*MINOR*	L	T	P	C
							3	1	0	4
Pre-requisite			None							

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	**Bloom's Learning (BL) Level**	**Program Learning Outcomes (PLO)**										
			PLO-1	**PLO-2**	**PLO-3**	**PLO-4**	**PLO-5**	**PLO-6**	**PLO-7**	**PLO-8**	**PLO-9**	**PLO-10**	**PLO-11**
			Domain Specific Knowledge	Critical Thinking and Problem Solving	Inter and Multi-disciplinary Skills	Lifelong learning	Research Aptitude	Creativity	Communication Skills	Innovation and Entrepreneurship	Vocational and Industry Exposure	Environmental awareness and sustainability	Ethics
CLO-1	Comprehend which mathematical objects are groups and categorise them into groups such as permutation, cyclic, and abelian groups.	2	H	H	M	M	M	M	-	M	-	M	M
CLO-2	Illustrate the basic ideas of symmetrical figures and groupings.	3	H	H	H	M	m	M	-	M	-	H	M
CLO-3	Identify and categorise cyclic group subgroups through analysis.	3	H	H	H	M	H	M	-	M	-	H	M
CLO-4	Examine the concepts of direct products and normal subgroups.	3	H	H	M	H	M	M	-	-	M	H	H

CLO-5	Compare Group isomorphisms and homomorphisms	3	H	M	M	M	M	H	-	H	-	H	M

(Level of correlation: ***3-High, 2-Medium, 1-Low*** can be used)

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
Unit 1	**INTRODUCTION TO GROUPS** Symmetries of a square - dihedral groups - definition and examples of groups including permutation Groups and quaternion groups (illustration through matrices) - elementary properties of groups.	12	CLO1
Unit 2	**SUB GROUPS** Subgroups and examples of subgroups - centralizer - normalizer - center of a group - product of two Subgroups.	12	CLO2
Unit 3	**CYCLIC GROUPS** Properties of cyclic groups - classification of subgroups of cyclic groups. Cycle notation for Permutations - properties of permutations - even and odd permutations - alternating group - Properties of cosets - Lagrange's theorem and consequences including Fermat's Little theorem	12	CLO3
Unit 4	**DIRECT PRODUCTS** External direct product of a finite number of groups - normal subgroups - factor groups - Cauchy's Theorem for finite abelian groups.	12	CLO4
Unit 5	**HOMOMORPHISMS AND ISOMORPHISMS** Group homomorphisms - properties of homomorphisms - Cayley's theorem, properties of isomorphisms - First, Second and Third isomorphism theorems.	12	CLO5

Learning Resources

Text Books	1. Gallian J.A., Contemporary Abstract Algebra, 4th Ed., Narosa Publishing House, New Delhi,1999. 2. Dummit D.S. & Foote R. M., Abstract Algebra 3rd Ed., Wiley, 2011.
Ref. Books	1. Rotman J. J., An Introduction to the Theory of Groups, 4th Ed., Springer Verlag,1995. 2. Herstein, I.N., Topics in Algebra, Wiley, India,2006. 3. Fraleigh J. B., A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.

Learning Assessment											
	Bloom's Level of Thinking	**Continuous Learning Assessment (40% weightage)**								**Final Examination (60% weightage)**	
		CLA – 1 (10%)		**CLA – 2 (10%)**		**CLA – 3 (10%)**		**CLA – 4 (10%)**			
		Theory	**Other Assessment**	**Theory**	**Other Assessment**	**Theory**	**Other Assessment**	**Theory**	**Other Assessment**	**Theory**	**Other Assessment**
Level 1	Remember	**50%**	**50%**	**50%**	**50%**	**30%**	**30%**	**30%**	**30%**	**30%**	-
	Understand										-
Level 2	Apply	**50%**	**50%**	**50%**	**50%**	**40%**	**40%**	**40%**	**40%**	**40%**	-
	Analyze										-
Level 3	Evaluate	-	-	-	-	**30%**	**30%**	**30%**	**30%**	**30%**	-
	Create	-	-	-	-						-
		100%		**100%**		**100%**		**100%**		**100%**	-

Course Designers		
Experts from Industry: Name, Designation with official mail id	Experts from Higher Education Institutions: Name, Designation with official mail id	Internal Experts: Name, Designation with official id
Name: Dr. Jagdish Chandra Saraswatula *Designation : Director of Product Management, Brooks Automation, Germany* ***Email: Jagdish.saraswatula@gmail.com***	*Name: Prof. Prem Pal* *Designation: Professor, Indian Institute of Technology, Hyderabad.* *Email: prem@iith.ac.in*	*Name: Bikash Thakuri* *Designation: Assistant Professor, SRM University Sikkim* ***Email: bikashthakuri.p@srm***

SEMESTER-IV

Course Code	**MAA23MI41**	**Course Name**	**Applied Statistics Using Softwares**	**Course Category**	*MI*	*MINOR*	L	T	P	C
							2	0	2	3
Pre-requisite			None							

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	**Bloom's Learning (BL) Level**	**Program Learning Outcomes (PLO)**										
			PLO-1	**PLO-2**	**PLO-3**	**PLO-4**	**PLO-5**	**PLO-6**	**PLO-7**	**PLO-8**	**PLO-9**	**PLO-10**	**PLO-11**
			Domain Specific Knowledge	Critical Thinking and Problem Solving	Inter and Multidisciplinary Skills	Lifelong learning	Research Aptitude	Creativity	Communication Skills	Innovation and Entrepreneurship	Vocational and Industry Exposure	Environmental awareness and sustainability	Ethics
CLO-1	Define the foundations in	2	H	H	H	M	H	M	-	M	-	M	H

	the principles of statistics.												
CLO-2	Demonstrate basic Statistical techniques.	3	H	H	H	H	H	M	-	M	-	H	H
CLO-3	Develop the concepts of measures of dispersion.	3	H	H	H	M	H	M	-	M	-	H	M
CLO-4	Analyze bivariate distribution.	3	H	H	M	H	M	M	-	-	M	H	H
CLO-5	Evaluate Random experimental models.	3	H	H	H	M	H	H	-	H	-	H	M

(Level of correlation: ***3-High, 2-Medium, 1-Low*** can be used)

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
Unit 1	**INTRODUCTION TO STATISTICS AND SOFTWARE TOOLS** Overview of statistics and its importance - Classification, tabulation - Diagrammatic representation of various types of statistical data - Introduction to R and SPSS - Data types and data collection - Basic data manipulation in R/SPSS	6	CLO1
Unit 2	**DESCRIPTIVE STATISTICS AND DATA VISUALIZATION** Measures of central tendency (Mean ,Mode and Median), and Measures of dispersion .Data visualization using R/SPSS - Probability distributions.	6	CLO2
Unit 3	**HYPOTHESIS TESTING AND CONFIDENCE INTERVALS** Hypothesis testing (t-tests, chi-square tests) - Confidence intervals - Type I and Type II errors.	6	CLO3
Unit 4	**REGRESSION ANALYSIS AND CORRELATION ANALYSIS** Concept of Bivariate distribution -Correlation - Definition-Uses – Types – Karl Pearson's Correlation Co-efficient –Scatter diagram - Spearman's Rank Correlation Co-efficient - Regression equations –	6	CLO4

	Regression Coefficient –Properties-Simple Problems- Applications Using Softwares.		
Unit 5	**ADVANCED TOPICS AND REAL-WORLD APPLICATIONS** Non-parametric statistics, ANOVA (Analysis of Variance) - Time series analysis - Practical applications in various fields (e.g., business, healthcare, social sciences).	6	CLO5

Additional 30 hours for Practical

Learning Resources	
Text Books	1. Gupta, S.P. (2011), "Applied Statistical Methods", 4th Edition, Sultan Chand & Sons, New Delhi. 2. Discovering Statistics Using R by Andy Field, Jeremy Miles, and Zoe Field.
Ref. Books	1. Pillai, R.S. N, Bagavathi, V. "Statistics, Theory and Practice", 7Th Edition, S. Chand Ltd, New Delhi 2009 2. Ken Black, "Business Statistics for Contemporary Decision Making", 7th Edition, John Wiley Publications 2013. 3. Nabendu Pal, "Statistics: Concepts and Applications", Prentice, India, Hall of India Pvt. Ltd.

Learning Assessment											
	Bloom's Level of Thinking	**Continuous Learning Assessment (40% weightage)**								**Final Examination (60% weightage)**	
		CLA – 1 (10%)		**CLA – 2 (10%)**		**CLA – 3 (10%)**		**CLA – 4 (10%)**			
		Theory	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**
Level 1	Remember	**50%**	**50%**	**50%**	**50%**	**30%**	**30%**	**30%**	**30%**	**30%**	-
	Understand										-
Level 2	Apply	**50%**	**50%**	**50%**	**50%**	**40%**	**40%**	**40%**	**40%**	**40%**	-
	Analyze										-

Learning Assessment											
	Bloom's Level of Thinking	**Continuous Learning Assessment (40% weightage)**								**Final Examination (60% weightage)**	
		CLA – 1 (10%)		**CLA – 2 (10%)**		**CLA – 3 (10%)**		**CLA – 4 (10%)**			
		Theory	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**
Level 1	Remember	**50%**	**50%**	**50%**	**50%**	**30%**	**30%**	**30%**	**30%**	**30%**	-
	Understand										-
Level 3	Evaluate	-	-	-	-	**30%**	**30%**	**30%**	**30%**	**30%**	-
	Create	-	-	-	-						-
		100%		**100%**		**100%**		**100%**		**100%**	-

Course Designers		
Experts from Industry: Name, Designation with official mail id	Experts from Higher Education Institutions: Name, Designation with official mail id	Internal Experts: Name, Designation with official id
Name: Dr. Jagdish Chandra Saraswatula *Designation : Director of Product Management, Brooks Automation, Germany* ***Email: Jagdish.saraswatula@gmail.com***	*Name: Prof. Prem Pal* *Designation: Professor, Indian Institute of Technology, Hyderabad.* *Email: prem@iith.ac.in*	*Name: Bikash Thakuri* *Designation: Assistant Professor, SRM University Sikkim* ***Email: bikashthakuri.p@srm***

Course Code	**MAA23MI51**	**Course Name**	**Real and Complex Analysis**	**Course Category**	*MI*	*MINOR*	L	T	P	C
							2	1	0	3
Pre-requisite			None							

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO-1	**PLO-2**	**PLO-3**	**PLO-4**	**PLO-5**	**PLO-6**	**PLO-7**	**PLO-8**	**PLO-9**	**PLO-10**	**PLO-11**
			Domain Specific Knowledge	Critical Thinking and Problem Solving	Inter and Multidisciplinary Skills	Lifelong learning	Research Aptitude	Creativity	Communication Skills	Innovation and Entrepreneurship	Vocational and Industry Exposure	Environmental awareness and sustainability	Ethics
CLO-1	Demonstrate the fundamental properties of the real numbers, including completeness and Archimedean, and density property of rational numbers in $\mathbb{R}$.	2	H	M	M	M	H	M	-	M	-	H	H
CLO-2	Explain different properties to prove the results about convergence and divergence of sequences and series of real numbers.	3	H	M	H	M	M	M	-	M	-	H	H
CLO-3	Examine continuity and differentiability of the different functions.	3	H	H	M	M	M	M	-	M	-	M	M
CLO-4	Analyze the fundamental properties of the Complex Functions.	3	H	H	M	H	M	M	-	-	M	M	H

CLO-5	Explain Continuity and differentiability of the different complex functions.	3	H	M	M	H	H	H	-	H	-	H	M

(Level of correlation: ***3-High, 2-Medium, 1-Low*** can be used)

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
Unit 1	**TOPOLOGY OF REAL LINE** Complete ordered field - Archimedean Property – Supremum – infimum - Neighbourhood of a point -Interior of a set-open set, closed set, Derived set, Closure of a set, Bolzano-Weierstrass Theorem, Brief introduction of compactness and connectedness.	9	CLO1
Unit 2	**SEQUENCE AND SERIES** Sequences - theorems on limit of sequences - Cauchy sequence and completeness. Infinite series - series of non-negative terms - Various tests for convergence - Alternating series - Leibnitz's theorem - Absolute convergence - Conditional convergence	9	CLO2
Unit 3	**CONTINUITY AND DIFFERENTIABILITY:** Continuity of functions - Discontinuities. Monotonic functions Uniform continuity, Differentiability.Taylor's theorem with various forms of remainders.	9	CLO3
Unit 4	**COMPLEX NUMBERS** Algebraic Properties of Complex Numbers, Powers and roots Regions in complex plane, The point at infinity and Stereographic projection, Elementary functions	9	CLO4
Unit 5	**CONTINUITY AND DIFFERENTIABILITY OF COMPLEX FUNCTIONS:** Limit, continuity and differentiability of functions of a complex variable, Cauchy Riemann equations, Analytic functions, Harmonic functions.	9	CLO5

Learning Resources	
Text Books	1. R. G. Bartle and D. R. Sherbert: Introduction to Real Analysis, John Wiley & Sons, 1999. 2. T. M. Apostol: Mathematical Analysis, Narosa Publishing House, New Delhi, 1985.

	3. J. B. Conway: Functions of One Complex Variable, Narosa Publishing House, 1980
Ref. Books	1. E. T. Copson: Complex Variables, Oxford University Press. 2. Richard R. Goldberg: Methods of Real Analysis, John Wiley & Sons, 1976.

Learning Assessment											
	Bloom's Level of Thinking	**Continuous Learning Assessment (40% weightage)**								**Final Examination (60% weightage)**	
		CLA – 1 (10%)		**CLA – 2 (10%)**		**CLA – 3 (10%)**		**CLA – 4 (10%)**			
		Theory	**Other Assessment**	**Theory**	**Other Assessment**	**Theory**	**Other Assessment**	**Theory**	**Other Assessment**	**Theory**	**Other Assessment**
Level 1	Remember	**50%**	**50%**	**50%**	**50%**	**30%**	**30%**	**30%**	**30%**	**30%**	-
	Understand										-
Level 2	Apply	**50%**	**50%**	**50%**	**50%**	**40%**	**40%**	**40%**	**40%**	**40%**	-
	Analyze										-
Level 3	Evaluate	-	-	-	-	**30%**	**30%**	**30%**	**30%**	**30%**	-
	Create	-	-	-	-						-
		100%		**100%**		**100%**		**100%**		**100%**	-

Course Designers

Experts from Industry: Name, Designation with official mail id	Experts from Higher Education Institutions: Name, Designation with official mail id	Internal Experts: Name, Designation with official id
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SEMESTER V

Course Code	**MAA23MI61**	**Course Name**	**Differential Equations**	**Course Category**	*MI*	*MINOR*	L	T	P	C
							3	1	0	4
Pre-requisite			None							

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	**Bloom's Learning (BL) Level**	**Program Learning Outcomes (PLO)**										
			PLO-1	**PLO-2**	**PLO-3**	**PLO-4**	**PLO-5**	**PLO-6**	**PLO-7**	**PLO-8**	**PLO-9**	**PLO-10**	**PLO-11**
			Domain Specific Knowledge	Critical Thinking and Problem Solving	Interdisciplinary Skills	Lifelong learning	Research Aptitude	Creativity	Communication Skills	Innovation and Entrepreneurship	Vocational and Industry Exposure	Environmental awareness and sustainability	Ethics
CLO-1	Formulate differential equations for various mathe	2	H	H	M	M	M	M	-	M	-	M	M

	matical models												
CLO-2	Interpret first order non-linear differential equations, linear differential equations of higher order and system of linear differential equations using various techniques.	3	H	H	M	M	H	M	-	M	-	M	H
CLO-3	Develop various methods of solving Partial differe	3	H	H	H	M	M	M	-	M	-	M	M

	ntial equations of first and Higher order and to have qualitative applications.												
CLO-4	Develop Problem solving skills for solving various types of partial differential equation especially hyperbolic, parabolic and elliptic types of PDE.	3	H	H	M	M	M	M	-	-	M	M	H
CLO-5	Explain a	3	H	H	H	M	M	H	-	H	-	H	M

	series solution of Differential equation by different methods.												

(Level of correlation: ***3-High, 2-Medium, 1-Low*** can be used)

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
Unit 1	**FIRST-ORDER DIFFERENTIAL EQUATIONS** General and singular solutions for the first order ordinary differential equation- Bernoulli's equation-Exact equations-Integrating factors- Initial value problems-Reducible second order differential equations	12	CLO1
Unit 2	**SECOND AND HIGHER-ORDER DIFFERENTIAL EQUATIONS** Linear homogenous equations with constant coefficients- Linear non-homogenous equations-The method of variation of parameters- The Cauchy-Euler equation, Simultaneous differential equations- Total differential equations.	12	CLO2
Unit 3	**PARTIAL DIFFERENTIAL EQUATION** Partial differential equations- Formation of partial differential equations-Types of solutions- PDEs of the first order. Lagrange's solution. Some special types of equations which can be solved easily by methods other than the general methods.	12	CLO3
Unit 4	**HIGHER ORDER PDE** Derivation of Heat equation -Wave equation and Laplace equation. Classification of second order linear equations as hyperbolic, parabolic or elliptic.	12	CLO4
Unit 5	**SERIES SOLUTION**	12	CLO5

	Series Solutions of Ordinary Differential Equations- Basic definitions-Power series-ordinary and regular singular points. Power series solutions of ODEs. Frobenius method.		

Learning Resources	
Text Books	1. Differential equations – J.N.Sharma and R.K.Gupta (Krishna PrakashanMandir Meerut) 2. Higher Engineering Mathematics by B. S.Grewal 3. C.Y. Lin, Theory and Examples of Ordinary Differential Equations, World Scientific, 2011.
Ref. Books	1. S. L. Ross, Differential Equations, 3rd Edition, John Wiley and Sons, India. 2. Erwin Kreyszig, *Advanced Engineering Mathematics*, 10th Edition, Willey 2011.

Learning Assessment											
	Bloom's Level of Thinking	**Continuous Learning Assessment (40% weightage)**								**Final Examination (60% weightage)**	
		CLA – 1 (10%)		**CLA – 2 (10%)**		**CLA – 3 (10%)**		**CLA – 4 (10%)**			
		Theory	**Other Assessment**	**Theory**	**Other Assessment**	**Theory**	**Other Assessment**	**Theory**	**Other Assessment**	**Theory**	**Other Assessment**
Level 1	Remember	**50%**	**50%**	**50%**	**50%**	**30%**	**30%**	**30%**	**30%**	**30%**	**-**
	Understand										**-**
	Apply	**50%**	**50%**	**50%**	**50%**	**40%**	**40%**	**40%**	**40%**	**40%**	**-**

Learning Assessment											
	Bloom's Level of Thinking	**Continuous Learning Assessment (40% weightage)**								**Final Examination (60% weightage)**	
		CLA – 1 (10%)		**CLA – 2 (10%)**		**CLA – 3 (10%)**		**CLA – 4 (10%)**			
		Theory	**Other Assessment**	**Theory**	**Other Assessment**	**Theory**	**Other Assessment**	**Theory**	**Other Assessment**	**Theory**	**Other Assessment**
Level 1	Remember	**50%**	**50%**	**50%**	**50%**	**30%**	**30%**	**30%**	**30%**	**30%**	-
	Understand										-
Level 2	Analyze										-
Level 3	Evaluate	-	-	-	-	**30%**	**30%**	**30%**	**30%**	**30%**	-
	Create	-	-	-	-						-
		100%		**100%**		**100%**		**100%**		**100%**	-

Course Designers		
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SEMESTER - VI

Course Code	MAA23M7	Course Name	Numerical Methods and Scientific Computing	Course Category	*MI*	*MINOR*	L	T	P	C
							3	0	2	4
Pre-requisite			None							

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	**Bloom's Learning (BL) Level**	**Program Learning Outcomes (PLO)**										
			PLO-1	**PLO-2**	**PLO-3**	**PLO-4**	**PLO-5**	**PLO-6**	**PLO-7**	**PLO-8**	**PLO-9**	**PLO-10**	**PLO-11**
			Domain Specific Knowledge	Critical Thinking and Problem Solving	Inter and Multidisciplinary Skills	Lifelong learning	Research Aptitude	Creativity	Communication Skills	Innovation and Entrepreneurship	Vocational and Industry Exposure	Environmental awareness and sustainability	Ethics
CLO-1	Demonstrate Basic concepts of Numerical analysis which includes different types of errors.	2	H	H	H	M	H	M	-	M	-	M	H
CLO-2	Interpret and Solve Transcendental and Algebraic equations by different numerical methods.	3	H	H	M	M	M	M	-	M	-	H	H

CLO-3	Apply different methods for finding solution of Linear system of equations.	3	H	H	H	M	M	M	-	M	-	H	M
CLO-4	Examine different problems to find an approximation solutions.	3	H	H	M	M	M	M	-	-	M	H	H
CLO-5	Explain Different types of equations by different methods.	3	H	H	H	M	H	H	-	H	-	H	M

(Level of correlation: ***3-High, 2-Medium, 1-Low*** can be used)

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
Unit 1	**ERRORS IN NUMERICAL CALCULATIONS** Absolute, Relative and Percentage errors, General Error, Error in series approximation.	9	CLO1
Unit 2	**SOLUTIONS OF ALGEBRAIC AND TRANSCENDENTAL EQUATIONS** Bisection method, False position method, Newton-Raphson Method, Picard's iteration method.	9	CLO2
Unit 3	**LINEAR SYSTEMS OF EQUATIONS** Consistency of Linear System of equations, Solutions of Linear Systems by direct method: Gaussian elimination and computation of inverse of a matrix, Method of Factorization, Solutions of linear systems by iterative methods: Jacobi method, Gauss-Siedel method.	9	CLO3

Unit 4	**INTERPOLATION AND CURVE FITTING** Errors in Polynomial interpolation, Finite differences, Differences of a polynomial, Newton's forward and backward interpolation, Central differences, Gauss, Stirling, Bessel's and Everett's Formulae, Lagrange's Interpolation formula.	9	CLO4
Unit 5	**NUMERICAL DIFFERENTIATION AND INTEGRATION** Numerical differentiation, Newton-Cotes Integration formula, Numerical integration by Trapezoidal rule, Simpson'1/3 and Simpson's 3/8.	9	CLO5

PRACTICAL/LAB WORK TO BE PERFORMED ON A COMPUTER: Use of computer aided software (CAS), for example Matlab / Mathematica / Maple / Maxima etc., for developing the following Numerical programs-30 hours.

- Finding of roots using Bisection Method
- Finding of root using Newton Raphson Method
- Finding of roots using Secant Method
- Finding of roots using Regular Falsi Method
- Solutions using Gauss-Jacobi Method
- Solutions using Gauss-Siedel Method
- Lagrange Interpolation or Newton Interpolation for polynomial functions
- Numerical Differentiation and Integration of different functions.

Learning Resources	
Text Books	1. S. S. Sastry: Introductory Methods Numerical Analysis, Prentice- Hall of India. 2. C.F. Gerald and P. O. Wheatley: Applied Numerical Analysis, Addison-Wesley, 1998.
Ref. Books	**REFERENCES** 1. Konte and Debour: Numerical Analysis.

Learning Assessment											
	Bloom's Level of Thinking	**Continuous Learning Assessment (40% weightage)**								**Final Examination (60% weightage)**	
		CLA – 1 (10%)		**CLA – 2 (10%)**		**CLA – 3 (10%)**		**CLA – 4 (10%)**			
		Theory	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**
Level 1	Remember	**50%**	**50%**	**50%**	**50%**	**30%**	**30%**	**30%**	**30%**	**30%**	-
	Understand										-
Level 2	Apply	**50%**	**50%**	**50%**	**50%**	**40%**	**40%**	**40%**	**40%**	**40%**	-
	Analyze										-
Level 3	Evaluate	-	-	-	-	**30%**	**30%**	**30%**	**30%**	**30%**	-
	Create	-	-	-	-						-
		100%		**100%**		**100%**		**100%**		**100%**	-

Course Designers		
Experts from Industry: Name, Designation with official mail id	Experts from Higher Education Institutions: Name, Designation with official mail id	Internal Experts: Name, Designation with official id
Name: Dr. Jagdish Chandra Saraswatula *Designation : Director of Product Management, Brooks Automation, Germany* ***Email: Jagdish.saraswatula@gmail.com***	*Name: Prof. Prem Pal* *Designation: Professor, Indian Institute of Technology, Hyderabad.* *Email: prem@iith.ac.in*	*Name: Bikash Thakuri* *Designation: Assistant Professor, SRM University Sikkim* ***Email: bikashthakuri.p@srm***

Ability Enhancement Course (AEC)

Semester I

Course Code		Course Name	Fundamentals of Computer	Course Category	*AEC*	Ability Enhancement Course	L	T	P	C
							1	0	1	2
Pre-requisite				**Co-requisite**						

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	**Bloom's Learning (BL) Level**	**Program Learning Outcomes (PLO)**												**PSO's**	
			PLO-1	PLO-2	PLO-3	PLO-4	PLO-5	PLO-6	PLO-7	PLO-8	PLO-9	PLO-10	PLO-11	PLO-12	PSO-1	PSO-2
			Problem Solving	Critical Thinking	Creativity	Communication Skills	Analytical Skills	Research Related Skills	Leadership Skills	Learning how to Learn Skills	Digital & Technological Skills	Multicultural Competencies & Inclusive Skills	Value Inculcation	Community Engagement	Industry Readiness	Higher Studies
CLO-1	Introduce the concept computer fundamentals and digital media	1	H	H	-	-	-	-	-	H	L	-	-	-	L	L
CLO-2	Demonstrate the use of office	3	H	H	M	-	-	-	-	H	M	-	-	-	M	H

	package and tools															
CLO-3	Apply the statistical tools on data sheets.	3	H	H	-	-	-	-	-	H	M	-	-	-	M	H
CLO-4	Analyse the data through charts and graphs	3	H	H	M	-	-	-	-	H	M	-	-	-	M	H
CLO-5	Create and design good presentation	6	H	H	M	-	-	-	-	H	H	-	-	-	M	H

(Level of corre1ation: ***3-High, 2-Medium, 1-Low*** can be used)

Summary of Course Content			
S. No	**Course Content**	**Hour**	**A1ignment to CLO**
1.	**Computer and its Applications:** **Introduction-** Practical application of computers in various fields e.g. business, banking, education, research, engineering etc. **Software & its types**- System software, Application Software, Free and Open Source Software; **Operating System**s- User Interface (CLI, GUI, Touch, Voice, Gesture based Interface), Functions of OS. Batch OS, Multiprogramming System, Multi-Processing System Time Sharing System, Online & Real-time OS; **Networking**- Importance of Networking, Topologies, LAN, WAN, Models (OSI & TCP/IP), Protocols.	9	CLO-1, 2
2.	**MS-Word**: **Introduction to MS Word:** overview of MS Word, getting started with word interface, creating, opening and saving documents, spell and grammar check, printing documents, using templates; **Page setting** – Document setup and layout, page orientation (portrait & landscape), page margins and size, page breaks, adding and editing headers and footers, page numbering; **Page Design and formatting** – text formatting(usage of different font styles, colors, size etc), paragraph formatting, styles and themes, text boxes , shapes, images and graphics, charts and symbols, page	9	CLO-3, 4

	borders and shading, tables, watermarks; **Review-** Spelling & Grammar, Define, Thesaurus, word count, translate, language, comments.		
3.	**MS- Excel:** **Introduction to Microsoft Excel:** Overview of the Excel interface, Workbook, worksheets, and cells, Data entry and editing, using autofill, creating and saving workbooks, opening existing workbooks. **Formulas and Functions:** Basic arithmetic functions (SUM, AVERAGE, COUNT, MAX, MIN), logical functions (TRUE, FALSE, IF, AND, OR, and NOT), Date and time(DATE, DATEVALUE, DAY, EDATE ETC), Lookup & Reference (ADDRESS, AREAS, HYPERLINK, HLOOKUP, VLOOKUP,INDEX, COLUMNS, ROWS etc.), Text functions (CONCATENATE,CHAR, REPLACE,LEN, LEFT, RIGHT, MID etc.), Cell references (relative, absolute, mixed); **Data Formatting and Conditional Formatting:** Formatting cells (font, borders, fill color) Number formatting (currency, percentage, date), Conditional formatting rules (highlighting, data bars, color scales)	9	CLO-5
4.	**Advance MS-Excel:** **Data Sorting and Filtering:** Sorting data in Excel, Filtering data using AutoFilter and advanced filter, using custom filter criteria, filtering by color and icon sets; **Statistical Functions and Analysis:** Descriptive statistics (AVERAGE, STDEV, MEDIAN), Histograms and frequency distributions, Data analysis tools; **Working with dashboard and Linking sheets in Excel**: Hyperlinks, cell references, create data links from multiple worksheets; **Data Visualization:** Creating charts (bar, line, pie, scatter, etc.), Formatting and customizing charts **Data Import and Export:** Importing data from external sources (CSV, text files), exporting data to different formats.	9	CLO-5
5.	**MS- PowerPoint:** **Getting started with power Point**-Power Point Presentation Interface, Create Presentation, Working with Presentation Layouts, Formatting Slides, Templates, Inserting Slides; **Advance Text Editing**- Indenting, Adding images and Clip, Animations, Slide Transition, Sounds; **Tables and Charts**- Creating tables in PowerPoint, formatting and customizing table elements, inserting charts for Data Visualization, modifying and customizing chart types, Inserting charts from Excels; **View Slides**-Slide navigation, normal view, slide sorter view, reading view, slide show	9	CLO-5

Learning Resources	
Text Books	1. Fundamentals of computers- by Rajaraman v, Adabala n 2. Computing fundamentals and c programming- by E. Balagurusamy
Ref. Books	1. Computer fundamentals concepts systems and applications- by Priti Sinha, Pradeep Sinha

Bloom's Level of Thinking		Continuous Learning Assessment (20% weightage)				Open Assessment (20% weightage)		Final Examination (60 % weightage)
		CA1 (5)	CA2 (5)	CA3 (5)	CA4 (5)	Assignment/ GD/ Field Trip/ Presentation (10)	Quiz/ Surprise Test (10)	
1	Remember	*50%*	*25%*	*20%*	*10%*	*20%*	*20%*	*20%*
2	Understand	*50%*	*25%*	*20%*	*10%*	*20%*	*30%*	*20%*
3	Apply	*0*	*20%*	*10%*	*20%*	*10%*	*30%*	*20%*
4	Analyze	*0*	*30%*	*10%*	*20%*	*10%*	*20%*	*20%*
5	Evaluate	*0*	*0*	*20%*	*20%*	*20%*	*0*	*20%*
6	Create	*0*	*0*	*20%*	*20%*	*20%*	*0*	*0*
	Total	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*100*

Course Designers		
Experts from Industry: Name, Designation with official mail id	Experts from Higher Education Institutions: Name, Designation with official mail id	Internal Experts: Name, Designation with official id
Mr. Bishnu Prasad Misra, Software Architect, Ericsson India Pvt. Ltd.	***Dr. Rashmita Khilar Professor, Department of IT, Saveetha School of Engineering, SIMATS***	***Dr. Om Prakash Sharma, Assistant Professor, Dept-IT, SRMUS***

SEMESTER-II

Course Code	UN123AE01	Course Name	COMMUNICATIVE SKILLS: LISTENING AND SPEAKING SKILLS	Course Category	*AE*	*Ability Enhancement Course*	L	T	P	C
							1	0	2	2
Pre-requisite			Nil	**Co-requisite**		Nil				

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	**Bloom's Learning (BL) Level**	**Program Learning Outcomes (PLO)**								
			PLO - 1	**PLO - 2**	**PLO - 3**	**PLO - 4**	**PLO - 5**	**PLO-6**	**PLO-7**	**PLO-8**	**PLO -9**
			Disciplinary Knowledge	Inter/ Multi-Disciplinary Skills	Research & Critical Thinking	Communication Skills	Reflective Thinking	Digital & Technological Literacy	Value Inculcation: Moral, Ethical, Literary, Environmental & Human	Creativity	Community Engagement & Lifelong Learning
CLO-1	Identify strategies to become appreciative and empathetic listeners.	2	H	M	M	H	M	L	H	M	M
CLO-2	Demonstrate an understanding of essential grammar rules and its usage.	3	H	H	M	H	M	L	M	M	M
CLO-3	Interpret accurately a range of non-verbal signals	6	H	H	M	H	H	M	M	M	H
CLO-4	Analyze the basic features of business communication	4	H	H	M	H	M	L	M	M	H
CLO-5	Communicate effectively in spoken English with fluency and accuracy	4	H	M	M	H	M	M	M	M	M
			3	**2.6**	**2**	**3**	**2.2**	**1.4**	**2.2**	**2**	**2.6**
	Average		**H**	**M**	**M**	**H**	**H**	**M**	**M**	**M**	**H**
(Level of correlation: ***3-High, 2-Medium, 1-Low*** can be used)											

Summary of Course Content			
Sr. No	**Course Content**	**Hour**	**Alignment to CLO**
Unit I	**Listening Skills (10 hr)** Introduction to Listening Active and Passive Listening Types of Listening – Appreciative, Emphatic, Critical, Comprehensive, Superficial Traits of a good Listener Techniques of effective listening Barriers to listening Art of Questioning- Purpose of questioning, Characteristics of questioning, Techniques of questioning **Activity Based Learning** Exercises from Language Lab (Intermediate & Proficient Level) *Classroom Activity:* Listening to the news and making notes, listening to announcements, listening to speeches, listening to instructions and summarizing them, Asking questions leading to discussion, Participation in conversation through questioning.	9	CLO 1
Unit II	**Grammar Practice (10 hr)** Types and forms of verbs, Tense Forms and Subject Verb Agreement, Determiners, Prepositions of Time and Place, Active and Passive Voice **Activity Based Learning** Exercises from Language Lab (Intermediate & Proficient Level) Activity from Worksheet	9	CLO 2
Unit III	**Non-Verbal Communication (5hr)** Definition, Significance of Non-verbal Signals Types of Nonverbal communication- Kinesics- Paralinguistic- Proxemics and Chronemics Do's and Don'ts, Learning from experts	9	CLO3
Unit IV	**Verbal Communication (5 hr)** Communication- Formal and Informal Effective communication- ABC and 7Cs of Communication Methods of Communication- Internal and External communication Networks of communication Vertical- horizontal- diagonal	9	CLO 4
Unit V	**Speaking Skills (15 hr)** Purposes of Speaking- Interpersonal, Formal and Semi Formal, Task Oriented, Persuasive Errors of Speech Conversation, Presentation, Interviews, Group Discussion, Public Speaking (Theory and Practice) **Activity Based Learning** Exercises from Language Lab (Intermediate & Proficient Level) Classroom Activity: Peer Introduction, Just a Minute, Role play, Product description (Adzap), Debate	9	CLO 5

Learning Resources	
Text Books	Raman Meenakshi, Sangeeta Sharma, "Technical Communication Principles and Practice". Ed Second. Oxford University Press, Delhi, 2013. Raman, Meenakshi, Prakash Singh, "Business Communication". Press, 2013 Edition. Oxford University.
Ref. Books	Green,David. "Contemporary English Grammar Structures and Composition." Macmilllian Publisher India Ltd, Delhi, 2000. Taylor, Shirley, V. Chandra. "Communicaton for Business. 4 2011 Ed. Dorling KIndersly India Pvt. Ltd.

Bloom's Level of Thinking		**Continuous Internal Assessment (100% weightage)**									
		CIA- 1 Unit Test- I		**CIA- 2 Unit Test- II**		**CLA – 3 Unit Test - III**		**CLA – 4 Unit Test - IV**		**CLA – 5 Unit Test - V**	
		Theory	**Practice**	**Theory**	**Practice**	**Theory**	**Practice**	**Theory**	**Practice**	**Theory**	**Practice**
1	Remember	*15%*	*15%*		*20%*	*20%*		*30%*		*15%*	*15%*
2	Understand	*15%*	*15%*		*20%*	*20%*	*10%*	*20%*		*15%*	*15%*
3	Apply		*10%*		*30%*		*20%*	*20%*	*10%*		*10%*
4	Analyse	*15%*	*15%*		*20%*	*20%*	*10%*	*10%*	*10%*	*15%*	*15%*
5	Evaluate	-			*10%*	-				-	
6	Create	-		-						-	
	Total	**100%**		**100%**		**100%**		**100%**		**100%**	

CIA – Each Unit Test will be conducted for 25 Marks. .

Course Designers		
Experts from Industry: Name, Designation with official mail id	**Experts from Higher Education Institutions: Name, Designation with official mail id**	**Internal Experts: Name, Designation with official id**
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Semester III

Course Code		**Course Name**	Internet & Information Communication Technologies	**Course Category**	*AEC*	Ability Enhancement Course	L	T	P	C
							1	0	1	2
Pre-requisite				**Co-requisite**						

Course Learning	*At the end of this course,*	**Bloom's Learn**	**Program Learning Outcomes (PLO)**												**PSO's**	
			PLO-1	PLO-2	PLO-3	PLO-4	PLO-5	PLO-6	PLO-7	PLO-8	PLO-9	PLO-10	PLO-11	PLO-12	PSO-1	PSO-12

Outcomes (CLO)	*learners will be able to:*	**ing (BL) Level**	Problem Solving	Critical Thinking	Creativity	Communication Skills	Analytical Skills	Research Related Skills	Leadership Skills	Learning how to Learn Skills	Digital & Technological Skills	Multicultural Competencies & Inclusive Skills	Value Inculcation	Community Engagement	Industry Readiness	Higher Studies
CLO-1	Introduce the concept of Internet, its applications	1	H	H	-	-	-	-	-	H	L	-	-	-	L	L
CLO-2	Express the various types of email communications	2	H	H	M	-	-	-	-	H	M	-	-	-	M	H
CLO-3	Demonstrate the use of ERP & ICT tools	3	H	H	-	-	-	-	-	H	M	-	-	-	M	H
CLO-4	Access the University LMS	4	H	H	M	-	-	-	-	H	M	-	-	-	M	H
CLO-5	Apply the ethical skills in social communication and research activity	5	H	H	M	-	-	-	-	H	H	-	-	-	M	H

(Level of corre1ation: ***3-High, 2-Medium, 1-Low*** can be used)

Summary of Course Content			
S. No	**Course Content**	**Hour**	**A1ignment to CLO**

1.	**Basics of Internet:** **Internet overview**- Applications of Internet, Domain Name System, URLs; **Internet Services**- ISP, Accessing the internet website & bookmark, Searching information using Search engine, University internet services (STPI, GIO); **WWW**- Importance, Maintaining University Website, Web accessibility and usability, Accessing e-journals, e-books, Library module; **Open AI**- Tools and Utility Accessing sites or information repository for curriculum and research. Eg – Courseera, Nptel, Swayam etc.	9	CLO-1
2.	**Basics of E-mail: Email overview**- Providers, services, basics of email communication and terminology; **Working with email**- mail-id creation**,** e-mail operation, organizing emails in folders; **Email Features**- understanding the purpose of "To", "CC", "BCC", sending and receiving email attachments, filters and rules for email organization, Voice based Content; **Email Etiquettes**- email etiquette and professionalism guidelines, handling confidential information in emails; **University Mail-ids-** familiarity with the university email policies, compliance with security and data protection guidelines, admin, faculty, and students mail accounts, email groups and lists for collaborative communication.	9	CLO-2
3.	**Enterprise Resource Planning & Information and Communication technology in** **Educational Institutions:** **Projectors and Board Cameras**: Understanding the functionality and setup of projectors. Interactive whiteboards and their use in classrooms. Utilizing board cameras for document sharing and live annotation. Practical exercises on using projectors and board cameras. Connecting the Wi-Fi, connecting the HDMI cable. **Overview of ERP**: Introduction to Enterprise Resource Planning (ERP) systems. Role of ERPs in educational institutions for management and administration. Features and benefits of ERP software in streamlining operations. Case studies and practical examples of ERP implementations in education.	9	CLO-3
4.	**University Learning Management System:** **Overview of LMS**- Learning management system and its role in education, working of the university LMS, navigation, user roles, content creation, and assessment tools within an LMS. **Google Classroom**- overview of Google Class room , benefits and features, creation of classroom, adding and managing students, navigating through Google classroom- interface tour(Stream, classwork, people, grades), creating assignment, quizzes and questions, adding resources(docs, slides, links),posting	9	CLO-4

	announcements , Projects, Posting materials, grading , using rubrics, providing feedback. **Video conferencing tools:** Google-meet, zoom, Microsoft teams etc.		
5.	**Social media & Plagiarism:** **Social media platforms:** overview of major platforms (Twitter, Facebook, LinkedIn, Instagram etc.), importance of social media in communication and networking; **Using social media effectively:** Creating and optimizing profiles, content creation and posting strategies, advertising, building and engaging with an audience, social media analytics and performance measurement **Social media communication ethics:** importance of ethical communication in social media, understanding online privacy, data protection and content, ethical considerations while sharing data, addressing cyberbullying and online harassment; **Plagiarism check-** practical usage of plagiarism detection software (e.g. drillbot), and interpreting reports to maintain originality in academic work, plagiarism detection and citation assistance; **Grammarly** - features, grammar and writing style improvement, integrating grammarly into different writing platforms.	9	CLO-5

Learning Resources	
Text Books	1. The Complete Reference to Internet- by Margaret Leving Young 2. Internet Technologies and Information Services- by Joseph B. Miller MD
Ref. Books	3. Internet Technology and Applications- by Mario Freire & Manuela Pereira

Bloom's Level of Thinking		**Continuous Learning Assessment (20% weightage)**				**Open Assessment (20% weightage)**		**Final Examination (60 % weightage)**
		CA1 (5)	**CA2 (5)**	**CA3 (5)**	**CA4 (5)**	**Assignment/ GD/ Field Trip/ Presentation (10)**	**Quiz/ Surprise Test (10)**	
1	Remember	***50%***	***25%***	***20%***	***20%***	***20%***	***20%***	***20%***

2	Understand	***50%***	***25%***	***30%***	***30%***	***30%***	***30%***	***30%***
3	Apply	***0***	***20%***	***30%***	***30%***	***20%***	***30%***	***20%***
4	Analyze	***0***	***30%***	***20%***	***20%***	***30%***	***20%***	***30%***
5	Evaluate	***0***	***0***	***0***	***0***	***0***	***0***	***0***
6	Create	***0***	***0***	***0***	***0***	***0***	***0***	***0***
	Total	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100***

Course Designers		
Experts from Industry: Name, Designation with official mail id	Experts from Higher Education Institutions: Name, Designation with official mail id	Internal Experts: Name, Designation with official id
Mr. Bishnu Prasad Misra, Software Architect, Ericsson India Pvt. Ltd.	***Dr. Rashmita Khilar Professor, Department of IT, Saveetha School of Engineering, SIMATS***	***Dr. Om Prakash Sharma, Assistant Professor, Dept-IT, SRMUS***

SEMESTER-IV

Course Code	**UN123AE03**	**Course Name**	**Communicative Skills: Reading and Writing Skills**	**Course Category**	*AE*	***Ability Enhancement Course***	**L**	**T**	**P**	**C**
							1	**0**	**2**	**2**
Pre-requisite			Nil	**Co-requisite**		Nil				

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	**Bloom's Learning (BL) Level**	**Program Learning Outcomes (PLO)**								
			PLO - 1	**PLO - 2**	**PLO - 3**	**PLO - 4**	**PLO - 5**	**PLO-6**	**PLO-7**	**PLO-8**	**PLO -9**
			Disciplinary Knowledge	Inter/ Multi-Disciplinary Sk	Research & Critical Thinking	Communication Skills	Reflective Thinking	Digital & Technological Literacy	Value Inculcation: Moral, Ethical, Literary, Envi	Creativity	Community Engagement

				ills					ronmental & Human		& Lifelong Learning
CLO-1	Acquire the ability to read for a variety of purposes	3	H	M	M	H	M	L	M	M	M
CLO-2	Demonstrate improved reading skills by comprehending and analyzing various types of written texts	4	H	H	H	H	M	L	M	M	M
CLO-3	Produce well-structured written documents, including letters and essays.	6	H	H	H	H	H	M	M	M	H
CLO-4	Practice the unique qualities of professional writing style	6	H	H	M	H	M	H	M	M	H
CLO-5	Demonstrate practical writing skills for online and digital platform	6	H	H	M	H	M	H	M	M	M
			3	**2.8**	**2.4**	**3**	**2.2**	**2**	**2**	**2**	**2.6**
	Average		**H**	**M**	**M**	**H**	**H**	**M**	**M**	**M**	**H**
(Level of correlation: ***3-High, 2-Medium, 1-Low*** can be used)											

Summary of Course Content			
Sr. No	**Course Content**	**Hour**	**Alignment to CLO**
Unit I	**Reading Skills** Types of Reading- Intensive, Extensive, Skimming, Scanning Reading for note making and summarizing Techniques of effective reading **Activity Based Learning** Exercises from Language Lab (Intermediate & Proficient Level) **Classroom Activity**: Reading articles and short stories and verbally summarizing them, reading newspapers and magazines and highlighting information, reading novels/ novella, Fictions of all types	9	CLO 1
Unit II	**Techniques in Reading Comprehension** Gathering main ideas and supporting details information from a given text Making inferences and drawing conclusions Evaluating these ideas and information Interpret the text **Activity Based Learning** Exercises from Language Lab (Intermediate & Proficient Level) *Classroom Activity*: Reading comprehension passages, reading reviews, reading and interpreting the content, identifying topic sentences, themes, key points	9	CLO 2

Unit III	**Writing Skills: Letters and Essays** Introduction and Importance of Writing Letter writing- Thank you and follow-up letter, complaint letter, inquiry letter, invitation letter, letter to the editor Essays and Article Writing **Activity Based Learning** Exercises from Language Lab (Intermediate & Proficient Level) *Classroom Activity:* Writing different kinds of letters, Essays and Article Writing	9	CLO3
Unit IV	**Professional Writing** Writing memo, notice, agenda and minutes of the meeting Types of Reports- Informational and Analytical Poster Making for Campaigns, Events, Ads **Activity Based Learning** Exercises from Language Lab (Intermediate & Proficient Level) *Classroom Activity*: framing notices and memos and agendas, jotting down minutes of the meeting, Interpretation of data (flow charts, figures and pictures)	9	CLO 4
Unit V	**Writing through Digital Media** NETTIQUETTE Emails- Formulation of email address, Understanding email format, composition of emails Resume- Written and Digital, Cover Letters, resume in LinkedIn Social Media- WhatsApp, Facebook, X, Instagram Blogging, Podcast **Activity Based Learning** Exercises from Language Lab (Intermediate & Proficient Level) *Classroom Activity:* Writing Emails, Resume, blogging, Podcast, Using Social Media	9	CLO 5

Learning Resources	
Text Books	● Raman Meenakshi, Sangeeta Sharma, "Technical Communication Principles and Practice". Ed Second. Oxford University Press, Delhi, 2013. ● Raman, Meenakshi, Prakash Singh, "Business Communication". Press, 2013 Edition. Oxford University
Ref. Books	● Green,David. "Contemporary English Grammar Structures and Composition." Macmilllian Publisher India Ltd, Delhi, 2000 ● Taylor, Shirley, V. Chandra. "Communicaton for Business. 4 2011 Ed. Dorling KIndersly India Pvt. Ltd.

Bloom's Level of Thinking		**Continuous Internal Assessment (100% weightage)**											
		CIA- 1 Unit Test- I		**CIA- 2 Unit Test- II**		**CLA – 3 Unit Test - III**		**CLA – 4 Unit Test - IV**		**CLA – 5 Unit Test - V**			
		Theory	**Practice**	**Theory**	**Practice**	**Theory**	**Practice**	**Theory**	**Practice**	**Theory**	**Practice**		
1	Remember	*15%*	*15%*	*10%*	*10%*		*20%*		*20%*		*20%*		

2	Understand	*15%*	*15%*	*10%*	*10%*	*10%*	*10%*	*10%*	*10%*	*10%*	*10%*		
3	Apply	*10%*	*10%*	*20%*	*20%*		*30%*		*30%*		*30%*		
4	Analyse	*10%*	*10%*	*10%*	*10%*	-		-		-			
5	Evaluate	-				-		-		-			
6	Create	-		-			*30%*		*30%*		*30%*		
	Total	**100%**		**100%**		**100%**		**100%**		**100%**			

CIA – Each Unit Test will be conducted for 25 Marks. .

Course Designers		
Experts from Industry: Name, Designation with official mail id	**Experts from Higher Education Institutions: Name, Designation with official mail id**	**Internal Experts: Name, Designation with official id**
Mr. Amit Patro Industry Expert (External Member) Editor, Sikkim Express, Gangtok, Sikkim, amitpatro19@gmail.com	Dr. Dilip P. Barad Subject Matter Expert (External Member) Professor, Department of English, M.K. Bhavnagar University, Bhavnagar, Gujarat, dilipbarad@gmail.com	Ms. Manisha Thakuri, Assistant Professor, SRM University Sikkim, manisha.t@srmus.edu.in

Value Added Courses (VAC)

SEMESTER I

Course category	Course code	Course Name	L	T	P	C
VAC	UNI23VA11	Environmental science	3	0	0	3

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	Bloom's Learning (BL) Level	Program Learning Outcomes (PLO)										
			PLO-1	**PLO-2**	**PLO-3**	**PLO-4**	**PLO-5**	**PLO-6**	**PLO-7**	**PLO-8**	**PLO-9**	**PLO-10**	**PLO-11**
			Domain Specific Knowledge	Critical Thinking and Problem Solving	Inter and Multidisciplinary skills	Life-long learning	Research Aptitude	Creativity	Communication Skills	Innovation and Entrepreneurship	Vocational and Industry Exposure	Environmental awareness and sustainability	Ethics
CLO-1	Define the basic concepts and importance of Environmental Education	1	**H**	**-**	**H**	**H**	**H**	**M**	**M**	**M**	**M**	**H**	**H**
CLO-2	Explain the causes, types and effects of different pollution types	2	**H**	**-**	**H**	**H**	**H**	**M**	**M**	**M**	**M**	**H**	**H**
CLO-3	Identify the interrelationship between energy, environment and society	2	**H**	**-**	**H**	**H**	**H**	**M**	**M**	**M**	**M**	**H**	**H**
CLO-4	Analyse the importance of Biodiversity and Conservation and its relation with environment	3	**H**	**H**	**H**	**H**	**H**	**M**	**M**	**M**	**M**	**H**	**H**
CLO-5	Evaluate the effects of global warming	4	**H**	**H**	**H**	**H**	**H**	**M**	**M**	**M**	**M**	**H**	**H**
			H	**H**	**H**	**H**	**H**	**M**	**M**	**M**	**M**	**H**	**H**

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**

1	**Introduction to Environmental Education** Environment and its components, Ecology and its organization, Environmental issues of Indian Himalayas, Overview of Environmental impact assessment.	10	CLO1
2	**Pollution** Types of Pollution–causes and effects and control measures. Waste management: prevention and control measures of solid waste and plastic pollution and its management.	10	CLO2
3	**Energy, environment and society** Different types energy, Conservation of energy resources and sustainable growth of society	5	CLO3
4	**Biodiversity and Environment** Biodiversity and its conservation, Interrelations between environment and biodiversity Threatened flora and fauna of India.	10	CLO4
5	**Global warming and climate change** The Earth's climate, Major characteristics of Climate Change and its causes, Introduction to glaciology, Global and Indian policies, measures and programs to mitigate Climate Change	10	CLO5

Learning Resources	
Text Books	1. P.D. Sharma (2011). Ecology and Environment. Rastogi Publications, Meerut 2. J.S. Singh, S.P. Singh and S.R. Gupta (2014). Ecology, Environmental Science and Conservation. 4th Edition. S. Chand & Company Pvt. Ltd
Ref. Books	1. Mitra, A.P., Sharma, S., Bhattacharya, S., Garg, A., Devotta, S. &Sen, K. 2004. 2. Climate Change and India. Universities Press, India 3. De. A.K, "Environmental Chemistry", New Age International, New Delhi, 1996 4. Singh, J.S., Singh, S.P., Gupta, S. (2006). Ecology Environment and Resource Conservation.

Learning Assessment											
	Bloom's Level of Thinking	**Continuous Learning Assessment (100% weightage)**								**Final Examination (0% weightage)**	
		CLA – 1 (25%)		**CLA – 2 (25%)**		**CLA – 3 (25%)**		**CLA – 4 (25%)**			
		Theory	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**
Level 1	Remember	**50%**	**50%**	**50%**	**50%**	**30%**	**30%**	**30%**	**30%**	-	-
	Understand									-	-
Level 2	Apply		**50%**	**50%**		**40%**		**40%**		-	-

	Analyze	**50 %**			**50 %**		**40 %**		**40 %**	-	-
Level 3	Evaluate	-	-	-	-	**30%**	**30 %**	**30%**	**30 %**	-	-
	Create									-	-
		100%		**100%**		**100%**		**100%**		-	-

CLAs can be from any combination of these: Group discussion, MCQ, Debate, Field work, Final field report, Poster making

Course Designers		
Experts from Industry: Name, Designation with official mail id	Experts from Higher Education Institutions: Name, Designation with official mail id	Internal Experts: Name, Designation with official id
1. Dr. Ratnesh Kumar Tripathi, Application Scientist & Head, Diagnostics & Genomics Solutions Division and Center of Excellence, Aglient Technologies ratnesh.tripathi@agilent.com	1. Dr. Bomba Dam, Assistant Professor, Dept. of Botany, Visva-Bharati, Santiniketan bomba.dam@visva-bharati.ac.in 2. Dr. Saurav Moktan, Assistant Professor, Dept. of Botany, University of Calcutta sauravmkn@gmail.com	1. Dr. Samjetsabam Bharati Devi, Assistant Professor & Head, Dept. of Botany, SRM University Sikkim. samjetsabambharatidevi.d@srmus.edu.in

Course Code	**UNI23VA11**	**Course Name**	**Understanding India**	**Course Category**	**VA**	**Value Added**	**L**	**T**	**P**	**C**
							1	**0**	**2**	**2**
Pre-requisite			**Nil**	**Co-requisite**		**Nil**				

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	**Bloom's Learning (BL) Level**	**Program Learning Outcomes (PLO)**								
			PLO-1	**PLO-2**	**PLO-3**	**PLO-4**	**PLO-5**	**PLO-6**	**PLO-7**	**PLO-8**	**PLO-9**
			Disciplinary Knowledge	**Critical Thinking**	**Problem Solving**	**Research / Analytical Skills**	**Team Work**	**Ethical Reasoning**	**Community Engagement**	**Leadership Skills**	**Life Long Learning**
CLO-1	Define the ancient background of India's culture and its impact.	1	H	M	L	M	L	M	M	H	H
CLO-2	Analyse the development of Indian education system	2	H	M	L	M	L	M	M	H	H
CLO-3	Demonstrate the socio-economic condition of India	3	H	M	L	M	L	M	M	H	H
CLO-4	Examine the various policies and programs in India	4	H	M	L	M	L	M	M	H	H
CLO-5	Analyse India's population scenario.	4	H	M	L	M	L	M	M	H	H

(Level of correlation: ***3-High, 2-Medium, 1-Low*** can be used)

Unit	Course Content	Hour	Alignment to CLO
I	**UNIT I: BACKGROUND OF INDIA'S CULTURAL DIVERSITY**	**12**	**CLO1**
	Harappan civilisation and Vedic age, Buddhism, Jainism, Sanatan (Hinduism) and Islam. Culture change and its impact in today's India.		
II	**UNIT II: GROWTH AND DEVELOPMENT OF INDIAN HIGHER EDUCATION**	**12**	**CLO2**
	Bharat's Natyashastra, Kalidas, Panini, Patanjali, Taxila, Nalanda, Vishwa Bharati, BHU, AMU, IIT, IISC, AIIMS, Nobel Laureates from India.		
III	**UNIT III: SOCIO-ECONOMIC STATUS OF INDIA**	**12**	**CLO3**
	Indian Economy – Major features & Challenges; Economic Growth – GDP & its Components; Development – HDI & its Components; Understanding of Govt. Budget		
IV	**UNIT IV: POLICIES AND PROGRAMS IN INDIA**	**12**	**CLO4**
	New Government Policy towards Indian Education; New Health care Schemes and Swachh Bharat Mission- Urban 2.0, Indian Policy in the field of Science and Technology (STIP), Development of Environment and Sustainability in India; Roles and Sustainable India 2047: Growth and Environmental Stewardship, Family Welfare Program; concepts, aims and objectives, Goals and Various strategies.		
V	**UNIT V: INDIA'S POPULATION**	**12**	**CLO5**
	Sources of Population Data, Major Demographic Trends in India, Causes of Population Growth in India, Effects of Overpopulation.		

Learning Recourses	
TEXT BOOKS	1. L. Basham, A Cultural History of India, Oxford University Press, 1997 2. L. Basham, A Wonder that was India, Rupa, New Delhi, 1994 3. Uma Kapila, Indian Economy Performances and Policies, Academic Foundation, Latest Edition
REFERENCES	1) N. R. Ray, An Approach to Indian Art, Publication Bureau, Chandigarh, 1974 2) Nayanjot Lahiri, Marshaling the Past: Ancient India and its Modern Histories, Permanent Black, 2012 3) Cultural History of India, New Age International Limited Publication.2005 4) Tharoor. Shashi, India:From Midnight to the Millennium and beyond.2006 5) Sen. Amartya. The Argumentative Indian: writing on Indian History, culture and identity, 2006 6) Ramchandra Guha, India after Gandhi: the history of the World's largest democracy,2007

Bloom's Level of Thinking		Continuous Internal Assessment (100% weightage)									
		CLA- 1		CLA- 2		CLA – 3		CLA – 4		CLA – 5	
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
1	Remember	*10%*	*20%*	*10%*	*20%*	*10%*	*20%*	*10%*	*20%*	*10%*	*20%*

2	Understand	*10%*	*20%*	*10%*	*20%*	*10%*	*20%*	*10%*	*20%*	*10%*	*20%*
3	Apply	*10%*	*10%*	*10%*	*10%*	*10%*	*10%*	*10%*	*10%*	*10%*	*10%*
4	Analyse	*10%*	*10%*	*10%*	*10%*	*10%*	*10%*	*10%*	*10%*	*10%*	*10%*
5	Evaluate	-		-		-		-		-	
6	Create	-		-		-		-		-	
	Total	**100%**		**100%**		**100%**		**100%**		**100%**	

Course Designers		
Experts from Industry: Name, Designation with official E-mail	Experts from Higher Education Institutions: Name, Designation with official E-mail	Internal Experts: Name, Designation with official E-mail
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		Dr. Rajshree Rai ***Assistant Professor*** rajshree.l@srmus.edu.in
	Dr. Komal Singha ***Professor, Department of Economics Sikkim Central University, Sikkim*** Email id: ksingha@cus.ac.in	Dr. Niranjan Debnath Assistant Professor *Department of Economics* *SRM University Sikkim* *niranjan.d@srmus.edu.in*

Course Code	**UNI23VA03**	**Course Name**	**Universal Human Values**	**Course Category**	*VA*	***Professional Core Courses***	**L**	**T**	**P**	**C**
							1	**1**	**2**	**3**
Pre-requisite			Nil	**Co-requisite**		Nil				

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	**Bloom's Learning (BL) Level**	**Program Learning Outcomes (PLO)**								
			PLO-1	**PLO-2**	**PLO-3**	**PLO-4**	**PLO-5**	**PLO-6**	**PLO- 7**	**PLO-8**	**PLO-9**
			Disciplinary Knowledge	Inter/Multi-Disciplinary Skills	Research & Critical Thinking	Communication Skills	Reflective Thinking	Digital & Technological Literacy	Value Inculcation: Moral, Ethical, Literary, Environmental & Human	Creativity	Community Engagement & Lifelong Learning
CLO-1	Apply ethical values to real-life situations	**Example:** 2	H	H	M	M	H	L	H	M	M

CLO-2	Engage across cultures with respect and dignity	4	H	H	M	H	M	L	H	M	H
CLO-3	Communicate and connect in empathetic dialogue with everyone	4	H	H	M	H	M	M	H	H	H
CLO-4	Recognize their duty as responsible citizens, advocating for social justice and human rights	4	H	H	M	M	H	L	H	M	M
CLO-5	Reflect on and express their personal values	5	H	H	M	M	H	M	H	M	M
			3	**3**	**2**	**2.4**	**2.6**	**1.4**	**3**	**2.2**	**2.4**
	Average		**H**	**H**	**M**	**H**	**H**	**M**	**H**	**H**	**H**
(Level of correlation: ***3-High, 2-Medium, 1-Low*** can be used)											

Summary of Course Content			
Sr. No	**Course Content**	**Hour**	**Alignment to CLO**
Unit I	**Human Values** • Love & Compassion, Truth, Non-Violence, Righteousness, Peace, Service, Renunciation (Sacrifice), Gratitude	9	CLO 1
Unit II	**Understanding Harmony and Ethical Human Conduct** • Harmony in the Self, Family, Society & Nature	9	CLO 2
Unit III	**Empathetic Communication & Personal Values** • Active Listening and Empathy, Communicating across differences, Constructive Dialogue and Conflict Resolution • Self-awareness and Values Assessment, Personal Values and Decision-making, Aligning personal values with Universal Values	9	CLO3

Unit IV	**Professional Ethics** • Optimum use of Institutional Resource, Gender Sensitization, Regard to Health & Safety, Grievance Committee • Integrity, Loyalty, Teamwork, Confidentiality, Objectivity, Growth Mindset, Competence and Accountability	9	CLO 4
Unit V	**Seminar Presentation on Human Values** *Students can choose any one assignment from the following listed below:* • Applying course concepts to practical scenarios through community engagement or social work • Personal Reflection Journal • Group Presentation – analyzing real-world situations & ethical dilemmas / article review / reviewing films, documentaries & books	9	CLO 5

Learning Resources	
Text Books	1. R R Gaur, R Asthana, G P Bagaria, "A Foundation Course in Human Values and Professional Ethics", 2nd Revised Edition, Excel Books, New Delhi, 2019. 2. Mulvah Pravah 2.0, Inculcation of Human Values and Professional Ethics in Higher Educational Institutions. University Grants Commission. Deeya Media Art, 2023. 3. Career Development Department. "INSIGHT." SRM University.
Ref. Books	Coelho, Paul. *The Archer*. Knopf, 2020. E.F. Schumacher. *Small is Beautiful*. Blond & Briggs, 1973. Gandhi, MK. *An Autobiography or The Story Of My Experiments With Truth.* Rupa, 2011. Kumar, Sujit. "The Pearson Guide to Verbal Ability for the CAT and Other MBA Examinations. Pearson Publication, 2013 Mitra, Barun K. "Personality Development and Soft Skills." Oxford University Press, Delhi, 2013. Mitchell, Stephen (trans). *Tao Te Ching*. Wisdom Tree, 2011. N. Tripathi, *Human Values*, New Age Intl. New Delhi, 2004. Rajaram, M. (trans). *Thirukkural*. Rupa, 2009. Rolland, Roman. *Life of Vivekananda Hardcover*. Advaita Ashrama, 2010.

Bloom's Level of Thinking		**Continuous Internal Assessment (40% weightage)**									
		CIA- 1 Assignment- I		**CIA- 2 Assignment- II**		**CLA – 3 Assignment - III**		**CLA – 4 Class Test**		**CLA – 5 Group Presentation**	
		Theory	**Practice**	**Theory**	**Practice**	**Theory**	**Practice**	**Theory**	**Practice**	**Theory**	**Practice**
1	Remember	***20%***	***10%***	***10%***	***10%***	***10%***		***10%***			

2	Understand	*20%*	*10%*	*10%*	*10%*	*10%*		*10%*		*20%*	*10%*
3	Apply	*10%*	*10%*		*20%*	*10%*	*10%*	*10%*	*10%*	*20%*	*10%*
4	Analyze	*10%*	*20%*		*20%*	*20%*	*10%*	*20%*	*10%*		
5	Evaluate	*10%*			*20%*	*20%*		*10%*	*10%*		
6	Create	-	-	-	-		*10%*		*10%*		*40%*
	Total	**100%**		**100%**		**100%**		**100%**		**100%**	

CIA –Assignments, Class Test & Group Presentations will be conducted for 20 Marks each.

Course Designers		
Experts from Industry: **Name, Designation with official mail id**	**Experts from Higher Education Institutions:** **Name, Designation with official mail id**	**Internal Experts:** **Name, Designation with official id**
Mr. Amit Patro Industry Expert (External Member) Editor, Sikkim Express, Gangtok, Sikkim, amitpatro19@gmail.com	Dr. Dilip P. Barad Subject Matter Expert (External Member) Professor, Department of English, M.K. Bhavnagar University, Bhavnagar, Gujarat, dilipbarad@gmail.com	Ms. Manisha Thakuri Chairperson Associate Dean, Faculty of Social Sciences and Humanities SRM University Sikkim, manisha.t@srmus.edu.in

Course Code	UNI23VA05	**Course Name**	NSS	**Course Category**		*Value Added Course*	L	T	P	C
							2		1	3

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	**Bloom's Learning (BL) Level**	**Program Learning Outcomes (PLO)**										
			PLO-1	**PLO-2**	**PLO-3**	**PLO-4**	**PLO-5**	**PLO-6**	**PLO-7**	**PLO-8**	**PLO-9**	**PLO-10**	**PLO-11**
			Problem Solving	Critical Thinking	Creativity	Communication Skills	Team Work	Ethical Reasoning	Leadership Skills	Learning how to Learn Skills	Digital & Technological Skills	Life Learning	Value Incuclcation
CLO-1	Understanding of Social Issues	1	H	H	-	-	H	-	-	H	L	-	-
CLO-2	Cultural Sensitivity and Diversity Awareness	2	H	H	M	-	H	-	M	H	M	-	-

CLO-3	Leadership and Teamwork Skill	3	H	H	-	-	H	-	H	H	M	-	H
CLO-4	Demonstrate ethical leadership	4	H	H	M	-	-	-	-	H	M	-	-
CLO-5	Self-Reflection and Personality Development	5	H	H	M	H	-	-	-	H	H	-	-

(Level of correlation: ***3-High, 2-Medium, 1-Low*** can be used)

Summary of Course Content			
S. No	**Course Content**	**Hour**	**Alignment to CLO**
1	**Introduction to National Service Scheme (NSS)** ● Overview of NSS: History, objectives, and significance ● Role of NSS in community development and social service ● Understanding the structure and functioning of NSS units ● Introduction to core principles and values of NSS	10	CLO1
2	**Social Issues and Community Needs Assessment** ● Identifying social issues and community needs ● Techniques for conducting community surveys and assessments ● Analyzing data and identifying priority areas for intervention ● Case studies on successful community development projects ● Field visits and interactions with community members	10	CLO2

3	**Community Engagement and Service Activities** ● Planning and organizing community engagement initiatives ● Implementing various service activities such as health camps, cleanliness drives, and awareness campaigns ● Collaborating with local NGOs, government agencies, and other stakeholders ● Reflection sessions to discuss experiences, challenges, and lessons learned Documentation and reporting of service activities and their impact	20	CLO3
4	**Ethical Leadership and Professional Conduct** ● Students will demonstrate ethical leadership skills ● uphold the principles of integrity, accountability, and transparency in all aspects of their engagement with communities ● adhering to professional standards and ethical guidelines.	10	CLO4
5	**Self-Reflection and Personality Development** ● Planning for leadership transition within NSS units ● Developing continuity plans to sustain ongoing projects and activities ● Mentoring and capacity building of junior NSS members ● Reflective sessions on personal growth and development during NSS tenure	10	CLO5

Learning Resources	
Text Books & Links	1. National Service Scheme: A youth Volunteers Program by JDS Panwar, Amit Kumar Jain and Brijesh Kumar Rathi 2016 2. National Social service Manual: https://nssmu.in/wp-content/uploads/2020/07/NSS-Manual.pdf

Bloom's Level of Thinking	**Continuous Learning Assessment (20% weightage)**				**Open Assessment (20% weightage)**		**Final Examination**
	Social activities (regular & special activities)						
	CA1 (15)	**CA2 (15)**	**CA3 (15)**	**CA4 (15)**	**Awareness program/ Field Trip/ Blood donation camp (40)**		

1	Understand	***50%***	***25%***	***20%***	***20%***	***30%***		
2	Apply	***50%***	***30%***	***30%***	***20%***	***15%***		
3	Analyze	***0***	***30%***	***10%***	***20%***	***15%***		
4	Evaluate	***0***	***15%***	***20%***	***20%***	***20%***		
5	Create	***0***	***0***	***20%***	***20%***	***20%***		
	Total	***100%***	***100%***	***100%***	***100%***	***100%***		

Course Designers		
Experts from Industry: Name, Designation with official mail id	Experts from Higher Education Institutions: Name, Designation with official mail id	Internal Experts: Name, Designation with official id
	Mr. Tsheten	***Ms. Ojaswani Dubey***
	Director NSS Officer Gangtok	***Ojaswani.d@srmus.edu.in***

SEMESTER-II

Course Code	**UN123VA01**	**Course Name**	**YOGA PRACTICES**	**Course Category**	*VA*	***Value Added Courses***	**L**	**T**	**P**	**C**
							1	**1**	**2**	**3**
Pre-requisite			Nil	**Co-requisite**		Nil				

Course Learning Outcomes (CLO)	*At the end of this course, learners will be able to:*	**Bloom's Learning (BL) Level**	**Program Learning Outcomes (PLO)**								
			PLO- 1	**PLO- 2**	**PLO- 3**	**PLO- 4**	**PLO- 5**	**PLO-6**	**PLO-7**	**PLO-8**	**PLO-9**
			Disciplinary Knowledge	Inter/ Multi-Disciplinary Skills	Research & Critical Thinking	Communication Skills	Reflective Thinking	Digital & Technological Literacy	Value Inculcation: Moral, Ethical, Literary, Environmental & Human	Creativity	Community Engagement & Lifelong

											Learning
CLO-1	Perform a range of asanas with correct alignmencct, recognizing the benefits and contraindications of each.	2	L	H	M	H	M	L	H	M	H
CLO-2	Effectively use pranayama techniques to control and direct the breath, influencing energy and mood.	3	M	H	M	M	H	L	H	M	H
CLO-3	Apply the principles of yamas and niyamas in daily life, reflecting a holistic approach to well-being	6	L	H	M	M	M	L	H	M	H
CLO-4	Utilize Yoga techniques (asanas, pranayama, meditation) to manage and reduce stress in daily life.	4	L	H	M	H	M	L	H	M	H
CLO-5	Develop a personal Yoga practice and understand the avenues for deeper study and specialization, whether in physical postures, meditation, or other branches of Yoga.	4	L	H	M	H	H	L	H	H	H
			1.2	**3**	**2**	**2.6**	**2.6**	**1**	**3**	**2.2**	**3**
	Average		**M**	**H**	**M**	**H**	**H**	**L**	**H**	**H**	**H**
(Level of correlation: ***3-High, 2-Medium, 1-Low*** can be used)											

Summary of Course Content			
Sr. No	**Course Content**	**Hour**	**Alignment to CLO**
Unit I	**History of Yoga** Introduction of Yoga, History of Yoga, *Patanjali's Yog Sutras* Ashtang Yoga- Yam, Niyam, Asana, Pranayam, Pratyahar, Dharana, Dhyan, Samadhi	9	CLO 1 CLO3 CLO 4 CLO5
Unit II	**Asana** Yogic Sukshma Vyayam Standing Asana- Tadasana, Utkatasana, Trikonasana, Virabhadrasana, Vrksasana, Natarajasana, Parsvottanasana, Garudasana, Prasarita Padottanasana Suryanamskar	9	CLO 2 CLO3 CLO 4 CLO5
Unit III	**Asana** Sitting Asanas: Dandasana, Padmasana, Baddha Konasana, Janu Sirsasana, Paschimottanasana, Gomukhasana, Ardha Matsyendrasana, Marichyasana, Kurmasana, Sukhasana, Lying Down (Supine/Prone) Asanas: Savasana, Setu Bandha Sarvangasana, Supta Baddha Konasana, Halasana, Sarvangasana, Matsyasana, Bhujangasana, Shalabhasana, Dhanurasana, Balasana	9	CLO3 CLO 2 CLO 4 CLO5
Unit IV	**Pranayama and Meditation** Kaplabhati, Anuloma Viloma, Bhramari, Bhastrika, Ujjayee, Sheetalee, Bandh- Jalandhar, Uddiyan, Mula Bhand Yogic Mudra, Yog Nidra, Body Awareness	9	CLO 2 CLO3 CLO 4 CLO5
Unit V	**Yogic Diet** Familiarity of Triguna, Significance of satvic vegetarian diet	9	CLO 4 CLO 5

Learning Resources	
Text Books	Swami Satyananda, Asana Pranayama Mudra Bandha. Yoga Publications Trust, 1997 Swami Vivekananda, Patanjali'S Yoga Sutras Paperback, Prabhat Prakashan Pvt. Ltd.. 2022 Ayushman Yog, Complete Guidebook for YCB Level 3 Yoga TTC: Yoga Teacher & Evaluator. Bigfoot Publications. 2023

Bloom's Level of Thinking		Continuous Internal Assessment (50% weightage)										Final (Practical) Examination (50 % weightage)	
		CIA- 1 Unit Test- I		CIA- 2 Unit Test- II		CLA – 3 Unit Test - III		CLA – 4 Unit Test - IV		CLA – 5 Unit Test - V			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
1	Remember	*15%*	*15%*		*20%*		*20%*		*20%*	*15%*	*15%*	*20%*	
2	Understand	*15%*	*15%*		*20%*		*20%*		*20%*	*15%*	*15%*	*20%*	
3	Apply		*10%*		*10%*		*10%*		*10%*		*10%*		*10%*
4	Analyse	*15%*	*15%*		*20%*		*20%*		*20%*	*15%*	*15%*		*20%*
5	Evaluate	-			*10%*		*10%*		*10%*	-			*10%*
6	Create	-		-	***20%***	-	***20%***	-	***20%***	-			***20%***
	Total	**100%**		**100%**		**100%**		**100%**		**100%**		**100%**	

- Students will submit the yoga practice workbook at the end of the semester, which will be evaluated out of 50 Marks.
- During the practical exam, students will perform various asanas and pranayama techniques, accompanied by oral responses.

Course Designers		
Experts from Industry: **Name, Designation with official mail id**	**Experts from Higher Education Institutions:** **Name, Designation with official mail id**	**Internal Experts:** **Name, Designation with official id**
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