Salesian College, Siliguri
(Autonomous)

National Education Policy (NEP) 2020 Curriculum Framework

For

Bachelor of Science in Physics

Offered by the

Department of Physics
Deanery of Sciences
Salesian College (Autonomous), Siliguri

NAAC Accredited A Grade (3rd cycle) and twice UGC certified College with Potential for Excellence (CPE)

Affiliated to the University of North Bengal
Siliguri - 734001
West Bengal

Vision

The vision of the Department of Physics is to build the rudiments for excellence and motivate the students to discover their latent talents through theoretical and practical physics and apply them to contribute to the betterment of self and of society and the nation at large.

Mission

The mission of the Department of Physics is to strive to attain high standards of excellence in generating and propagating knowledge in physics. The faculty members are committed to providing education that combines rigorous academics with the joy of discovery through nurturing a vibrant academic ambience conducive to study, creation, and dissemination of knowledge.

Exit Options:

Qualification	Exit Stage
Certificate in Physics	After successful completion of semesters I and II with 44 credits
Diploma in Physics	After successful completion of semesters I to IV with 86 credits
B.Sc. in Physics	After successful completion of semesters I to VI with 126 credits
B.Sc. (Hons.) in Physics	After successful completion of semesters I to VIII with 168 credits
B.Sc. (Hons. with Research) in Physics	After successful completion of semesters I to VIII with 168 credits, including 12 research credits

Program Objectives

Certificate in Physics

The Certificate course in Physics aims to provide

1. A comprehensive overview of introductory physics, mathematics and computation required to model and analyse elementary physical phenomena.
2. Development of analytical skills and competence in applying simple physical concepts to real life phenomena.
3. Encouragement and development of general critical and analytical thinking, scientific reasoning, problem-solving skills, written and verbal communication skills, and teamwork.
4. Self-conception with regard to moral and ethical awareness, leadership qualities, innovative ideas and life-long learning, and an appreciation for multicultural competence and multilingualism.
5. An ability to improve the knowledge and skills required to pursue higher levels of education or a career in the sciences.

Diploma in Physics

The Diploma course in Physics aims to provide

1. A comprehensive overview of the major areas of physics, mathematics and computation required to model and analyse general physical phenomena.
2. Development of analytical skills and competence in applying common physical concepts to real life phenomena.
3. Encouragement and development of general critical and analytical thinking, scientific reasoning, problem-solving skills, written and verbal communication skills, and teamwork.
4. Self-conception with regard to moral and ethical awareness, leadership qualities, innovative ideas and life-long learning, and an appreciation for multicultural competence and multilingualism.
5. An ability to improve the knowledge and skills required to pursue higher levels of education or a career in the sciences.

B. Sc. in Physics

The Bachelors course in Physics aims to provide

1. A comprehensive and detailed overview of all primary fields of physics, with the mathematical and computational background required to model and analyse most physical phenomena.
2. Development of analytical skills and competence in applying both common and abstract physical concepts to real life phenomena.
3. Encouragement and development of general critical and analytical thinking, scientific reasoning, problem-solving skills, written and verbal communication skills, and teamwork.
4. Self-conception with regard to moral and ethical awareness, leadership qualities, innovative ideas and life-long learning, and an appreciation for multicultural competence and multilingualism.
5. Sufficient knowledge to be able to participate in graduate and career entrance examinations such as IIT-JAM, CUET (PG), UPSC-CSE etc.

6. An ability to improve the knowledge and skills required to pursue higher levels of education or a career in the sciences.

B. Sc. (Hons./Hons. with Research) in Physics

The Bachelors (Hons./Hons. with Research) course in Physics aims to provide

1. A comprehensive and detailed overview of all primary fields of physics, with the mathematical and computational background required to model and analyse most physical phenomena.
2. A comprehensive and detailed overview of important advanced fields of physics.
3. Development of analytical skills and competence in recognizing and applying any pertinent physical concept to real life phenomena.
4. Encouragement and development of general critical and analytical thinking, scientific reasoning, problem-solving skills, written and verbal communication skills, and teamwork.
5. Self-conception with regard to moral and ethical awareness, leadership qualities, innovative ideas and life-long learning, and an appreciation for multicultural competence and multilingualism.
6. Sufficient knowledge to be able to participate in graduate/post-graduate and career entrance examinations such as IIT-JAM, CUET (PG), JEST, GATE, UPSC-CSE etc.
7. An ability to improve the knowledge and skills required to pursue higher levels of education or a career in the sciences.
8. Exposure to the latest advancements of physics, research and allied fields.

Program Outcomes

The learning outcomes of the undergraduate degree course in physics are

a) *Knowledgeable and Technically Capable*:
The graduate has the ability to apply the knowledge of basic science principles in the solution of complex problems of scientific and technical interest.

b) *Problem Solver*:
The graduate has the ability to identify, formulate and analyse complex scientific problems and reach substantiated conclusions using first principles of mathematical, computational and natural sciences.

c) *Innovative Thinker*:
The graduate has the ability to create, select and apply suitable techniques, resources and the use of modern analytical and scientific tools to identify, formulate and solve problems pertaining to applied science.

d) *Modern Tools Oriented*:
The graduate has the ability to apply appropriate techniques and resources of modern technology and computational tools for prediction and modelling of science problems.

e) *Scientifically Tempered*:
The graduate has the ability to develop a scientific temper and inquisitiveness for further studies, research and the promotion of scientific thinking.

f) *Effective Communicator*:
The graduate has the ability to communicate scientific and technical information in oral, written and graphical form to both science and lay audience.

g) *Group Worker*:
The graduate has the ability to work as a member and a leader in any team, and to manage projects and work in a multidisciplinary environment.

h) *Global Citizen*:
The graduate has an understanding of their professional, social and ethical responsibilities for a better society.

i) *Life-Long Learner*:
The graduate has the ability to recognize the need and importance of engaging in life-long learning.

Assessment

The Formative and Summative Assessments are to be evaluated as per the Assessment & Evaluation Policy Manual of Salesian College. For each course, the Board of Studies has provided a recommended, non-binding schema for assessment.

Proposed Courses offered by the Department of Physics
4 Year Bachelors Course

Semester	Paper Code	Paper	Credits (Theory)	Credits (Lab)	Teaching Hours
I	23PHYMAJ101	Calculus and Vector Analysis	4	0	4
	23PHYMAJ102	Mechanics and Properties of Matter	3	1	3 + 2
	23PHYSEC101	Introduction to Computers & Programming	0	3	6
	23PHYMDC101	Astronomy and Cosmology for the Curious	3	0	3
	23PHYVAC101	Quantum Crossroads I		1	2
		Total	**15**		**20**
II	23PHYMAJ103	Electricity and Magnetism	3	1	3 + 2
	23PHYMAJ104	Waves and Optics	3	1	3 + 2
	23PHYSEC102	Practical Electricity	2	1	2 + 2
	23PHYMDC102	Quantum Physics for the Curious	3	0	3
	23PHYMIN102	Mechanics	3	1	3 + 2
	23PHYVAC102	Quantum Crossroads II		1	2
		Total	**19**		**24**
III	23PHYMAJ201	Differential Eqns and Complex Analysis	4	0	4
	23PHYMAJ202	Digital Electronics	3	1	3+2
	23PHYSEC201	Numerical Methods using Computation	0	3	6
	23PHYMDC201	Physics of Sports	3	0	3
	23PHYVAC201	Quantum Crossroads III		1	2
		Total	**15**		**20**
IV	23PHYMAJ203	Thermal Physics	3	1	3 + 2
	23PHYMAJ204	Relativity and Modern Physics	3	1	3 + 2

	23PHYMAJ205	Analog Electronics	3	1	3 + 2
	23PHYMIN202	Electricity and Magnetism	3	1	3 + 2
	23PHYVAC202	Quantum Crossroads IV		1	2
		Total	**17**		**22**
V	23PHYMAJ301	Solid State Physics	3	1	3 + 2
	23PHYMAJ302	Analytical Mechanics	3	1	3 + 2
	23PHYMAJ303	Quantum Mechanics	3	1	3 + 2
	23PHYVAC301	Quantum Crossroads V		1	2
		Total	**13**		**17**
VI	23PHYMAJ304	Statistical Mechanics	3	1	3 + 2
	23PHYMAJ305	Atomic and Molecular Physics	3	1	3 + 2
	23PHYMAJ306	Elective I	4	0	4
	23PHYMIN302	Electronics	3	1	3 + 2
		Total	**16**		**19**
VII	23PHYMAJ401	Nuclear and Particle Physics	4	0	4
	23PHYMAJ402	Statistics and Research Methodology	3	1	3 + 2
	23PHYMAJ403	Advanced Mathematical Physics	4	0	4
	23PHYMAJ404 OR 23PHYMAJ405	Elective II Research	4 4	0	4 4
		Total	**16**		**17**
VIII	23PHYMAJ406	Advanced Electrodynamics	3	1	3 + 2
	23PHYMAJ407	Elective III	4	0	4
	23PHYMAJ408 23PHYMAJ409 OR 23PHYMAJ410	Introduction to Nanophysics Elective IV Research	4 4 8	0 0	4 4 8

	23PHYMIN402	Waves and Optics	3	1	3 + 2
		Total	**20**		**22**
		Grand Total	**131**		**161**

LIST OF ELECTIVES

Elective I	Elective II	Elective III	Elective IV
Physical Acoustics and Applications	Astronomy and Astrophysics	Advanced Quantum Mechanics	Advanced Solid State Physics
Magnetism in Materials	Nonlinear Dynamics and Chaos Theory	Physics of Radiation	Lasers and Advanced Optics

1. Programme Matrix of Courses offered by the Department of Physics (1st Year)

Semester	Course Code	Course Type	Title of the Course	Credit	Lecture Tutorial Practical (L+T+P)	Total Hours	Total Marks
I	23PHYMAJ101	Major	Calculus and Vector Analysis	4	3+1+0	60	100
	23PHYMAJ102	Major	Mechanics and Properties of Matter	4	3+0+1	75	100
	23PHYSEC101	SEC	Introduction to Computers & Programming	3	0+0+3	90	100
	23PHYMDC101	MDC	Astronomy and Cosmology for the Curious	3	3+0+0	45	100
	23PHYVAC101	VAC	Quantum Crossroads I	1	0+0+1	30	50
	Total			**15**		**300**	
II	23PHYMAJ103	Major	Electricity and Magnetism	4	3+0+1	75	100
	23PHYMAJ104	Major	Waves and Optics	4	3+0+1	75	100
	23PHYMIN102	Minor	Mechanics	4	3+0+1	75	100
	23PHYSEC102	SEC	Practical Electricity	3	2+0+1	60	100
	23PHYMDC102	MDC	Quantum Physics for the Curious	3	3+0+0	45	100
	23PHYVAC102	VAC	Quantum	1	0+0+1	30	50

			Crossroads II				
	Total			**19**		**360**	

Students' Progression Mapping			
RBT - Cognitive Level Mapping		**Dave's Psychomotor Mapping**	
Symbols	**Meaning**	**Symbols**	**Meaning**
R	Remembering	I	Imitation
U	Understanding	M	Manipulation
A1	Applying	P	Precision
A2	Analysing	A	Articulation
E	Evaluating	N	Naturalization
C	Creating		

Checked and verified by:	Approved by:	External Experts - Board of Studies
(Signature) Dr. Prajwal Chettri Head of the Department	(Signature) Mr. Subhajit Paul Dean of Sciences	(Signature) Dr. Ranjan Sharma Associate Professor Department of Physics Coochbehar Panchanan Barma University (Signature) Dr. Amitabha Bhattacharyya Associate Professor Department of Physics Sikkim University Gangtok, Sikkim (Signature) Mr. Tamanash Das Supervisor (Retd.) Draughtsman Civil Trade ITI Tollygunge Kolkata (Signature) Mr. Aaush Pradhan (Alumnus) 2018 batch

23PHYMAJ101 - Calculus and Vector Analysis

1. Course Description

Course Code	23PHYMAJ101
Course Title	Calculus and Vector Analysis
Credits	4
Total Hours	60
Hours per Week	4
Course Type	Major
Semester	I
Intended Level	Certificate
Issue(s) Addressed	
Course Offered to	Physics
Regulation	2023
Course Overview	This course: a. Aims to recapitulate basic understanding of calculus. b. Helps to explore the application of calculus in physics based problems. c. Helps to understand and apply the concept of vectors. d. Teaches the basic operations of vectors.
Prerequisite	Student must have introductory knowledge of limits, derivatives, integrals (definite and indefinite), partial fractions, and vectors
Course Objectives	A student will be able to: i. Develop skills in finding derivatives of functions and applying them to solve problems related to rates of change, optimization, etc. ii. Develop skills in solving definite and indefinite integrals and applying them to cases involving areas, volumes, and accumulation. iii. Understand the basic properties of vectors and their manipulation using addition, subtraction, scalar multiplication, and dot & cross products. iv. Understand vector equations and their applications in solving problems related to lines, planes, and curves. v. Introduce the concepts of vector differentiation and integration and their applications.

Course Outcomes based on RBT and Cognitive Level Mapping
At the end of this course, a student will be able to:

COs	Statements	Cognitive Level Mapping
CO1	Describe the concepts of integral and differential calculus in relation to the various physical and mathematical contexts.	R
CO2	Explain the importance of vector quantities in physics-based problems and restate the operation of vector quantities.	U

CO3	Classify and solve different kinds of derivatives, such as total, partial, exact and inexact derivatives, and apply them to physics-based problems.	A1		
CO4	Analyze the concept and properties of special functions such as Gamma function, Beta function, Dirac Delta function, etc., and apply them to solve numerical problems of physical interest.	A2		
CO5	Evaluate the different orthogonal coordinate systems and select the appropriate mutual and operator transformations.	E		
CO6	Construct solutions for real-life physics-based problems using vector differentiation & vector integration.	C		
Course Content				
Units	**Content**	**Lecture Hours**	**COs**	**RBT**
Unit I	**Single Variable Calculus** Functions of a single variable: plotting functions, tangent to the curve; continuity; instantaneous and average quantities; the derivative; chain rule; higher order derivatives; implicit differentiation; mean value theorem; maxima and minima; approximations using Taylor and binomial theorems Indefinite integrals; integrals by substitution; integration by parts; definite integrals; area under curves; first and second fundamental theorems of calculus; special techniques of integration: trigonometric substitution, partial fractions, completing the square, polar coordinates etc. The Gaussian integral; the Dirac delta function: representation as a limit of Gaussian and rectangular functions; basic properties Beta and Gamma functions and their properties; relation between beta and gamma functions; reduction of integrals to Gamma functions; the error function	**15**	**1, 4**	**R U A1 A2 E C**
Unit II	**Vector Algebra** Review of scalars and vectors; properties of vectors under rotations; scalar product and its	**5**	**2**	**R U A1 A2**

	invariance under rotation; vector product and interpretation as area; scalar triple product and interpretation as volume; vector triple product			**E C**
Unit III	**Multivariable Calculus** Orthogonal coordinate systems: Cartesian, spherical polar, and cylindrical polar coordinates, conversions between coordinate systems Partial derivatives and total derivatives; exact and inexact differentials; chain rule for partial derivatives; directional derivatives and the gradient; constrained maximization using Lagrange multipliers	**8**	**3, 5**	**R U A1 A2 E C**
Unit IV	**Vector Differentiation** Curves, surfaces, scalar and vector fields; time derivatives of a vector function Directional and normal derivatives; gradient of a scalar field and its geometric interpretation; divergence and curl of a vector field; the Laplacian operator; product rules and second derivatives of the del operator; gradient, divergence, curl and Laplacian in Cartesian, spherical and cylindrical coordinates (with derivation)	**8**	**1, 2, 6**	**R U A1 A2 E C**
Unit V	**Vector Integration** Parametric integrals of vector curves; infinitesimal line elements; line integrals and Green's theorem in a plane Multiple integrals and the Jacobian; infinitesimal surface and volume elements; surface integrals; areas of surfaces of revolution; volume integrals and determination of volumes; parameterization and coordinate conversions for integration Flux of a vector field; Gauss' divergence theorem; Stoke's theorem; applications	**9**	**1, 2, 6**	**R U A1 A2 E C**
Learning Resources: Textbooks 1. Dass, H.K. & Verma, R. (2019). *Mathematical physics* (8th ed.). S. Chand Publishing 2. Gupta, B.D. (2022). *Mathematical physics* (4th ed.). S. Chand Publishing				

3. Riley, K.F., Hobson, M.P., & Bence, S.J. (2018). *Mathematical methods for physics and engineering* (3rd ed.). Cambridge University Press
4. Nearing, J. (2010). *Mathematical tools for physicist*s. Dover Publications. http://www-mdp.eng.cam.ac.uk/web/library/enginfo/textbooks_dvd_only/nearing/math_methods.pdf
5. Thomas, G., Hass, J., Heil, C., & Weir, M. (2018). *Thomas' calculus* (14th ed.). Pearson Education
6. Spiegel, M., Lipschutz, S., & Spellman, D. (2009). *Schaum's outlines: Vector analysis* (2nd ed.). McGraw-Hill Education

Suggested Readings

1. Spiegel, M. (2009). *Schaum's outline of advanced mathematics for engineers and scientists*. McGraw-Hill Education
2. Anton, H., Bivens, I., & Davis Stephens. (2015). *Calculus* (10th ed.). Wiley
3. Kreyszig, E. (2017). *Advanced engineering mathematics* (10th ed.). Wiley
4. McMullen, C. (2018). *Essential calculus skills practice workbook with full solutions*. Zishka Publishing
5. Fernandez, O. (2017). *Everyday calculus: Discovering the hidden math all around us* (rev. ed.). Princeton University Press

R: Remembering, U: Understanding, A1: Applying, A2: Analysing, E: Evaluating, C: Creating

2. Assessment

The student **must** score a minimum of 40% of the total maximum marks assigned to the entire paper to pass the course, subject to the following restrictions: (i) the student **must** be present for and score a minimum of 40% in the Summative Assessment, (ii) the student must be present for Formative Assessment II (Mid-Semester Examinations), and (iii) the student should have a **minimum** of 75% attendance for the entire course.

Formative Assessment: 50 marks distributed across three different forms of Assessment. Evaluated as per the Assessment & Evaluation Framework Document of Salesian College.

Summative Assessment:The Summative Assessment will be a written examination of 50 marks of at least 2 hours duration, using the RBT categorization and scheme.

Section	Marks per question	No. of questions to be answered	No. of questions given	Total marks for Section
A	2	5	8	10
B	5	4	6	20
C	10	2	4	20
			Total	**50**

Evaluation Scheme of the entire Course

Component	Marks	Final Weightage	Final Marks
Summative Assessment	50	100%	50
Formative Assessment I	20	50%	10
Formative Assessment II	50		25
Formative Assessment III	20		10
Attendance	5	100%	5
		Total	100

Prepared by:	Checked and verified by:	Approved by:	External Experts - Board of Studies
(Signature) Ms. Sujata Sinha (Signature) Mr. Bikramjit Chandra	(Signature) Dr. Prajwal Chettri Head of the Department	(Signature) Mr. Subhajit Paul Dean of Sciences	(Signature) Dr. Ranjan Sharma Associate Professor Department of Physics Coochbehar Panchanan Barma University (Signature) Dr. Amitabha Bhattacharyya Associate Professor Department of Physics Sikkim University Gangtok, Sikkim (Signature) Mr. Tamanash Das Supervisor (Retd.) Draughtsman Civil Trade ITI Tollygunge Kolkata (Signature) Mr. Aaush Pradhan (Alumnus) 2018 batch

23PHYMAJ102 - Mechanics and Properties of Matter

1. Course Description

Course Code	23PHYMAJ102
Course Title	Mechanics and Properties of Matter
Credits	4
Total Hours	75
Hours per Week	5
Course Type	Major
Semester	I
Intended Level	Certificate
Issue(s) Addressed	
Course Offered to	Physics
Regulation	2023
Course Overview	This course: a. Aims to train the students in the basic knowledge of Physics, and the laws governing it. b. Helps to introduce the students to conservation laws and their utility in understanding the behaviour of physical systems. c. Focuses on the motion of rigid bodies about any fixed point and any arbitrary axis passing through this point. d. Helps the students understand the elastic properties of materials and the Physics behind the characteristics of liquids. e. Helps the students develop knowledge of the central force and its characteristics, including gravitation. f. Teaches the basics of harmonic motion and its characteristics. It will help the students understand the periodic motions in Nature.
Prerequisite	Students must have an introductory knowledge of kinematics in 1 and 2D, linear and rotational motion, energy, elasticity, Newtonian gravitation, and oscillations. Must take PHYMAJ101 concurrently
Course Objectives	A student will be able to: i. Acquire preliminary knowledge of the laws of motion, the concept of Galilean invariance, the system of particles, and collisions. ii. Demonstrate the concepts of conservative and non-conservative forces, fictitious forces, translational and rotational dynamics and the ability to calculate the moment of inertia of various rigid bodies. iii. Describe the general properties of matter and the principles of elasticity, fluid flow, viscosity, and surface tension. iv. Analyse the laws of gravitation and central force motion and derive Kepler's law to demonstrate the motion of planets. v. Explain the phenomenon of simple harmonic motion and the properties of the systems executing it.
Course Outcomes based on RBT and Cognitive Level Mapping	

At the end of this course, a student will be able to:				
COs	**Statements**	**Cognitive Level Mapping**		
CO1	Define and identify the fundamental laws of motion and associated concepts such as collisions	R		
CO2	Distinguish between inertial and non-inertial reference frames and interpret the physical consequences arising from them.	U		
CO3	Apply the motion of a particle under central force motion to demonstrate the properties and characteristics of gravitation.	A1		
CO4	Examine and investigate the general properties of matter and various physical constants.	A2		
CO5	Evaluate the differential equation of simple harmonic motion and assess the nature of oscillations.	E		
CO6	Construct the motion of a rigid body including translational & rotational motion.	C		
Course Content				
Units	**Content**	**Lecture Hours**	**COs**	**RBT**
Unit I	**Fundamentals of Dynamics and Non-Inertial Systems** Laws of motion, Galilean transformation, Conservation laws, System of particles and Centre of Mass, Motion of rockets. Elastic and Inelastic collisions, Laboratory and Centre of Mass frames. Conservative and non-conservative forces, Potential Energy. Potential energy curves and equilibrium. Work done by non-conservative forces. Law of Conservation of Energy. Non-inertial frames and fictitious forces. Uniformly rotating frame. Rotating coordinate systems. Centrifugal force. Coriolis force and its applications.	**13**	**1, 2**	**R U A1 A2 E C**
Unit II	**Rotational Dynamics:** Angular momentum of a particle and system of particles, Torque, Conservation of angular momentum, Rotation about a fixed axis, Rotational energy	**7**	**1, 6**	**R U A1 A2 E C**

	Moment of Inertia, Theorem of perpendicular axis and Theorem of parallel axes. Calculation of moment of inertia for rectangular, cylindrical and spherical bodies.			
Unit III	**Properties of Matter** **Elasticity**: Stress-Strain diagram, Relation between Elastic constants – Young's modulus, Bulk's modulus and modulus of rigidity. Poisson's ratio. Work done in stretching and in twisting a wire, twisting torque on a cylinder or wire. **Viscosity**: Streamline and Turbulent flow, Equation of Continuity, Coefficient of Viscosity by Poiseuille's method and Stoke's method. **Surface Tension**: Relation between surface tension and surface energy, pressure difference across curved surface, excess pressure inside spherical liquid drop. Angle of Contact and capillary ascent. Measurement of surface tension.	**9**	**4**	**R U A1 A2 E C**
Unit IV	**Gravitation and Central Force Motion** Law of Gravitation. Gravitational potential energy, potential, and field intensity. Motion of a particle under a central force field. Two-body problem, its reduction to a one-body problem, and its solution. The energy equation and energy diagram. Kepler's Laws. Satellites in circular orbits and escape velocity.	**8**	**3**	**R U A1 A2 E C**
Unit V	**Oscillations** Simple Harmonic Motion, its differential equation and solution. Vertical oscillations of the light loaded spring, expression for force constant and determination of acceleration due to gravity. Energy and their time-average values. Damped oscillations. Forced oscillations, transient and steady states, Resonance, sharpness of resonance, power dissipation and Quality Factor.	**8**	**5**	**R U A1 A2 E C**
Learning Resources: Text Books				

1. Mathur, D.S. (2000). *Mechanics*. S. Chand & Co.
2. Lal B. & Subrahmanyam N. (2002). *Properties of matter*. S. Chand & Co
3. Murugeshan R. (2010). *Elements of properties of matter*. S. Chand & Co.
4. Chatterjee, H. & Sengupta, R. (2010). A *treatise on general properties of matter* (7th rev. ed.). New Central Book Agency (P) Limited

Suggested readings

1. Kittel, K., Knight, W. D., Ruderman, M. A., Helmholz, A. C., & Moyer, B. J. (2011). *Mechanics*. Tata McGraw-Hill
2. Halliday, D., Resnick, R., & Walker, J. (2007) *Fundamentals of physics.* John Wiley & Sons
3. Kleppner, D. & Kolenkow, R. J. (2017) *An introduction to mechanics.* McGraw Hill Education

R: Remembering, U: Understanding, A1: Applying, A2: Analysing, E: Evaluating, C: Creating

Practicals

Course Code	23PHYMAJ102
Course Title	Mechanics and Properties of Matter
Credits	4
Total Hours	75
Hours per Week	5
Course Type	Major
Semester	I
Intended Level	Certificate
Issue(s) Addressed	
Course Offered to	Physics
Regulation	2023
Course Overview	This course: a. Helps introduce students to different measuring instruments and their applications and significance. b. Emphasises the need to have hands-on experience with the measurement of physical quantities and understand the theoretical concepts through practical means. c. Aims to help in estimating the physical properties of rigid bodies and the elastic and mechanical properties of different materials using scientific instruments. d. Aims to help in assessing the properties of liquids through simple experiments.
Prerequisite	Students must have an introductory knowledge of kinematics in 1 and 2D, linear and rotational motion, energy, elasticity, Newtonian gravitation, and oscillations. Must take PHYMAJ101 concurrently
Course Objectives	A student will be able to: a. Identify, choose, and calibrate appropriate measuring instruments for a particular experiment.

	b. Record experimental data in a systematic manner and compute the results using the right physical or mathematical procedures. c. Interpret and communicate their results in an appropriate manner using written reports with the necessary data visualizations. d. Check the credibility of theoretical claims from experiments. e. Nurture their scientific temperament and encourage them to build upon their experience gained from conducting experiments.

Course Outcomes based on Dave's Psychomotor Mapping
At the end of this course, a student will be able to:

COs	Statements	Cognitive Level Mapping
CO1	Replicate the steps required to familiarize themselves with experiments and instruments related to the study of mechanical and elastic properties.	I
CO2	Recreate any previously imitated experiment on the study of mechanical and elastic properties.	M
CO3	Demonstrate skilled use of common measuring instruments such as callipers, gauges, measuring telescopes, etc.	P
CO4	Be proficient in the setup and use of experimental apparatus used for the study of mechanical and elastic properties.	P
CO5	Adapt or modify previously imitated experiments to analyze new mechanical and elastic properties.	A

Course Content

Units	Content	Lecture Hours	COs	Dave's
Unit I	**List of Experiments:** 1. Measurements of length/ diameter using vernier calliper, screw gauge and travelling microscope 2. Determination of *g* and velocity of freely falling body using digital timing technique 3. To study the motion of a spring and calculate: (a) it's spring constant, (b) modulus of rigidity of the spring material and (c) value of *g*. 4. To measure the radius of curvature of a spherical surface using a spherometer 5. To determine the value of *g* using a bar pendulum	**30**	**1, 2, 3,4,5**	**I M P A**

	6. To determine the surface tension of a liquid by capillary tube method 7. To determine the coefficient of viscosity of water by Poiseuille's method 8. To determine the modulus of rigidity of the material of a wire by dynamical method 9. To determine the modulus of rigidity of the material of a wire by statical method 10. To determine the modulus of rigidity of the material of a wire by Maxwell's needle 11. To determine the Young's modulus of the material of a wire by optical lever method 12. To determine the moment of inertia of a flywheel ***A minimum of EIGHT (8) experiments is to be performed***			
Learning Resources: Text Books 1. Chattopadhyay, D. & Rakshit, P. C. (2011). *An advanced course in practical physics*. New Central Book Agency (P) Limited 2. Raychaudhuri, D. P. (n.d.). *Manual of practical physics*. Allied Book Agency 3. Dasgupta, C.R. (1985). *A handbook of practical physics.* Book Syndicate Private Limited 4. Singh, H. & Hemne, P.S. (2022). *B.Sc. practical physics*. S. Chand & Co. 5. Chandra, B. (2023). *PHY MAJ102P:Mechanics - Lab guidebook for practicals*. (n.p.)				

2. Assessment

The student **must** score a minimum of 40% of the total maximum marks assigned to the entire paper to pass the course, subject to the following restrictions: (i) the student **must** be present for and score a minimum of 40% in the Summative Assessment for theory and practical **each**, (ii) the student must be present for Formative Assessment II (Mid-Semester Examinations), and (iii) the student should have a **minimum** of 75% attendance for the entire course.

Formative Assessment: 50 marks distributed across three different forms of Assessment. Evaluated as per the Assessment & Evaluation Framework Document of Salesian College.
Summative Assessment (Theory):The Summative Assessment will be a written examination of 50 marks of at least 2 hours duration, using the RBT categorization and scheme.

Section	Marks per question	No. of questions to be answered	No. of questions given	Total marks for Section
A	2	5	8	10
B	5	4	6	20
C	10	2	4	20
			Total	**50**

Summative Assessment (Practical):The Summative Assessment will be an examination of 50 marks of at least 3 hours duration. The student will be made to perform one or more experiments chosen at random from the topics given in the syllabus.

Sl. No.	Component	Marks per component
1	Practical Examination	30
2	Viva-voce	10
3	Lab notebook or Lab assignment	10
	Total	**50**

Evaluation Scheme of the entire Course

Component	Marks	Final Weightage	Final Marks
Summative Assessment (Theory)	50	50%	25
Summative Assessment (Practical)	50		25
Formative Assessment I	20		10
Formative Assessment II	50		25
Formative Assessment III	20		10
Attendance	5	100%	5
		Total	100

Prepared by:	Checked and verified by:	Approved by:	External Experts - Board of Studies
(Signature) Dr. Digvijay Kharga (Signature) Mr. Mayukh Mazumdar (Signature) Dr. Prajwal Chettri	(Signature) Dr. Prajwal Chettri Head of the Department	(Signature) Mr. Subhajit Paul Dean of Sciences	(Signature) Dr. Ranjan Sharma Associate Professor Department of Physics Coochbehar Panchanan Barma University (Signature) Dr. Amitabha Bhattacharyya Associate Professor Department of Physics Sikkim University Gangtok, Sikkim (Signature) Mr. Tamanash Das Supervisor (Retd.) Draughtsman Civil Trade ITI Tollygunge Kolkata (Signature) Mr. Aaush Pradhan (Alumnus) 2018 batch

23PHYSEC101 - Introduction to Computers & Programming

1. Course Description

Course Code	23PHYSEC101
Course Title	Introduction to Computers and Programming
Credits	3
Total Hours	90
Hours per Week	6
Course Type	Skill Enhancement Course
Semester	I
Intended Level	Certificate
Issue(s) Addressed	
Course Offered to	Physics
Regulation	2023
Course Overview	This course: a. Introduces a student to the concept of using computers to enhance their scientific and numerical analysis skills. b. Trains a student in the construction and writing of technical scientific reports and papers. c. Teaches a student the basic concepts of programming using Python. d. Introduces tools and modules in Python used for advanced numerical and scientific analysis. e. Introduces the methods and skills needed to appropriately visualize technical data for analysis.
Prerequisite	Students must be able to type on a keyboard and use a mouse. They must have elementary knowledge of linear and polynomial equations, differentiation, integration, differential equations, statistics, and conic sections.
Course Objectives	A student will be able to: i. Learn about the benefits of FOSS software and common examples of them. ii. Write and construct a technical report or paper. iii. Acquire knowledge about the fundamentals of basic scientific and numerical programming using Python. iv. Use of common Python modules used in numerical and scientific programming, and their commonly used methods. v. Construct appropriate diagrams and charts for the purposes of data visualization and analysis.

Course Outcomes based on RBT and Cognitive Level Mapping
At the end of this course, a student will be able to:

COs	Statements	Cognitive Level Mapping
CO1	Identify the benefits of FOSS software and name common examples of them.	R

CO2	Express physical and mathematical phenomena using appropriate Python code and data visualization approaches.	U
CO3	Demonstrate physical phenomena or mathematical outcomes using Python code.	A1
CO4	Investigate a physical phenomenon computationally and outline its result in a technical report or paper.	A2
CO5	Determine parameters or evaluate the outcomes of physical situations using computational modelling with Python.	E
CO6	Design computational algorithms that replicate common physical phenomena.	C

Course Content

Units	Content	Lecture Hours	COs	RBT
Unit I	**FOSS and Operating Systems** **Lecture:** FOSS and its importance; the Four Essential Freedoms; meaning of proprietary software; examples of popular FOSS software and alternatives to proprietary software Operating Systems (overview only): Windows, Macintosh, Linux, Android; general overview of Linux distributions, packages and repositories **Lab:** Introduction to and the basic functions and FOSS software of the Manjaro operating system (or whichever Linux system is in use)	**6**	**1**	**R U A1 A2 E C**
Unit II	**Writing Technical Documents** **Lecture:** Overview of the LibreOffice software suite; introduction to LibreOffice Writer; fonts: serif, san-serif and monospace fonts; appropriate selection of fonts Desmos graphing calculator: line plots from functions and data points; areas, derivatives and integrals of curves, linear regression; polar plots	**14**	**4**	**R U A1 A2 E C**

	Writing and formatting a technical report/paper **Lab:** writing and formatting text; inserting and formatting images; using the formula editor; creating model graphs and graphs from data; typesetting pages for print; writing a technical report			
Unit III	**Introduction to Python Programming** **Lecture:** constants, variables and common data types; strings and string manipulation; *input()* and *print()* statements; arithmetic, comparative and boolean relations; *if-else* conditionals; *for* and *while* loops; nesting; *break* and *return*; lists and tuples: introduction, methods, and use in iteration; functions and recursion; writing files to and reading from disk; search algorithms: linear/sequential, front and back, and binary **Lab:** simple programs to demonstrate use of conditionals and loops; summation; sorting, generation of number series; searching lists; computation of areas and volumes.	**22**	**2, 3**	**R U A1 A2 E C**
Unit IV	**Modules for Scientific Computing** **Lecture:** Modules; examples of common modules used in daily and scientific computing (overview only); importing modules; the *math* module: common methods and functions The *numpy* and *scipy* modules; arrays, array operations; slicing; random number generation; the *linalg* submodule; functions for matrix and vector analysis: addition, multiplication, scalar and vector products, inverses, determinants, eigen values and vectors *solve()* - solutions of a linear system of equations; *roots()* - roots of a polynomial equation; mean and standard deviation; *polyfit()* - linear fitting to data, and *interp()* - linear interpolation; *gradient()* -	**26**	**5, 6**	**R U A1 A2 E C**

	numerical differentiation, and *trapz()* - numerical integration; *odeint()* - solutions of differential equations **Lab:** programs that demonstrate the use of modules and their inbuilt functions; conversion of coordinate systems; roots of equations used in physics; equation of a line from linear experimental data; velocity and acceleration at a point from displacement and vice-versa; areas of non-standard regions (e.g. BH loop)			
Unit V	**Data Visualization** **Lecture:** the *matplotlib* module; other popular visualization modules (overview only); formatting graphs: log and semilog axes, simple TeX notation; creating subplots Plotting of 2D data: line plots; scatter plots; histograms; polar plots Plotting of 3D data: surface plots; contour plots; colour maps **Lab:** solving and plotting trajectories of 2D motion and collisions; estimating and plotting lines of best fit for linear experimental data; plotting solutions of differential equations; line plots of curves in Cartesian and polar coordinates; plots of temperature distribution on 2D surfaces etc.	**22**	**5, 6**	**R U A1 A2 E C**

Learning Resources: (Latest edition books listed in APA style: Seventh Edition)

Open Online Resources

1. Free Software Foundation. (2021, February 2). *What is free software?* GNU Operating System. https://www.gnu.org/philosophy/free-sw.en.html
2. Linux Training Academy. (2023, n.d.). *Linux distribution: Introduction and overview*. Linux Training Academy. https://www.linuxtrainingacademy.com/linux-distribution-intro/
3. LibreOffice Documentation Team. (2022). *Writer guide 7.3*. https://documentation.libreoffice.org/assets/Uploads/Documentation/en/WG7.3/WG73-WriterGuide.pdf
4. Desmos. (2022, April 17). *Learn Desmos* [Video playlist]. Youtube. https://www.youtube.com/playlist?list=PLfM6zMGnbgOGLZc-_Yj3QVK3Vz_L4Cw59
5. Corey Schafer. (2019, April 22). *Python programming beginner tutorials* [Video playlist]. Youtube. https://www.youtube.com/playlist?list=PL-osiE80TeTskrapNbzXhwoFUiLCjGgY7

6. freeCodeCamp.org. (2019, August 7). *Python Numpy tutorial for beginners* [Video]. Youtube. https://www.youtube.com/watch?v=QUT1VHiLmmI&pp=ygUSZnJlZWNvZGVjYW1wIG51bXB5
7. Mr. P. Solver. (2021, June 1). *SciPy tutorial (2022): For physicists, engineers, and mathematicians* [Video]. Youtube. https://www.youtube.com/watch?v=jmX4FOUEfgU
8. sentdex. (2016, January 20). *Matplotlib tutorial series - Graphing in Python* [Video playlist]. Youtube. https://www.youtube.com/playlist?list=PLQVvvaa0QuDfefDfXb9Yf0la1fPDKluPF

Suggested readings

1. Stallman, R. (2015). *Free software, free society: Selected essays of Richard M. Stallman* (3rd ed.). GNU Press. https://www.gnu.org/doc/fsfs3-hardcover.pdf
2. Hering, L., & Hering, H. (2019). *How to write technical reports: Understandable structure, good design, convincing presentation*. Springer
3. Matthes, E. (2016). *Python crash course: A hands-on, project-based introduction to programming.* No Starch Press. https://bedford-computing.co.uk/learning/wp-content/uploads/2015/10/No.Starch.Python.Oct_.2015.ISBN_.1593276036.pdf
4. Sweigart, A. (2019). *Automate the boring stuff with Python* (2nd ed.). No Starch Press. https://automatetheboringstuff.com/
5. Idris, I. (2015) *Numpy beginner's guide: Build efficient, high-speed programs using the high-performance Numpy mathematical library*. Packt Publishing Ltd.
6. Johansson, R. (2018). *Numerical Python: Scientific computing and data science applications with Numpy, SciPy and Matplotlib*. Apress
7. Rougier, N. P. (2021) *Scientific visualization: Python + Matplotlib.* https://inria.hal.science/hal-03427242/document

R: Remembering, U: Understanding, A1: Applying, A2: Analysing, E: Evaluating, C: Creating

2. Assessment

The student **must** score a minimum of 40% of the total maximum marks assigned to the entire paper to pass the course, subject to the following restrictions: (i) the student **must** be present for and score a minimum of 40% in the Summative Assessment, (ii) the student must be present for Formative Assessment II (Mid-Semester Examinations), and (iii) the student should have a **minimum** of 75% attendance for the entire course.

Formative Assessment: 50 marks distributed across three different forms of Assessment. Evaluated as per the Assessment & Evaluation Framework Document of Salesian College.

Summative Assessment:The Summative Assessment will be an examination of 50 marks of at least 3 hours duration. The student will be made to write one or more computational programs chosen at random from the topics given in the syllabus.

Sl. No.	Component	Marks per component
1	Practical Examination	30
2	Viva-voce	10

3	Lab notebook or Lab assignment	10
	Total	**50**

Evaluation Scheme of the entire Course

Component	Marks	Final Weightage	Final Marks
Summative Assessment	50	100%	50
Formative Assessment I	20	50%	10
Formative Assessment II	50		25
Formative Assessment III	20		10
Attendance	5	100%	5
		Total	100

Prepared by:	Checked and verified by:	Approved by:	External Experts - Board of Studies
(Signature) Mr. Bikramjit Chandra	(Signature) Dr. Prajwal Chettri Head of the Department	(Signature) Mr. Subhajit Paul Dean of Sciences	(Signature) Dr. Ranjan Sharma Associate Professor Department of Physics Coochbehar Panchanan Barma University (Signature) Dr. Amitabha Bhattacharyya Associate Professor Department of Physics Sikkim University Gangtok, Sikkim (Signature) Mr. Tamanash Das Supervisor (Retd.) Draughtsman Civil Trade ITI Tollygunge Kolkata (Signature) Mr. Aaush Pradhan (Alumnus) 2018 batch

23PHYMDC101 - Astronomy and Cosmology for the Curious

1. Course Description

Course Code	23PHYMDC101
Course Title	Astronomy and Cosmology for the Curious
Credits	3
Total Hours	45
Hours per Week	3
Course Type	Multi-Disciplinary Course
Semester	I
Intended Level	Certificate
Issue(s) Addressed	
Course Offered to	All Students (except students who have studied Physics)
Regulation	2023
Course Overview	This course: a. Introduces a student to the large scale structure of the Universe at a qualitative level without any mathematical or technical prerequisites. b. Introduces the student to the history of astronomy in India and abroad until the discovery of universal gravitation. c. Gives the student an overview of the Solar System and its major components, stars and galaxies. d. Introduces the student to the Lambda-CDM Standard Model of cosmology in simple terms. e. Briefly acquaints the student with the biggest open problems in modern day cosmology. f. Gives the student an overview of important space organisations and missions.
Prerequisite	Students must have graduated from higher secondary school. Students cannot have studied physics in classes 11 & 12.
Course Objectives	A student will be able to: i. Understand and appreciate the history of astronomy in India and abroad until the discovery of universal gravitation. ii. Identify and summarise the important properties of all major bodies in the Solar System. iii. Summarize the processes of the creation and evolution of stars, how they radiate energy, and how they form galaxies. iv. Understand the arguments for Big Bang cosmology, summarise the evolution of the Universe, and discuss open problems in cosmology. v. Familiarize themselves with important space agencies and significant space missions and probes.

Course Outcomes based on RBT and Cognitive Level Mapping
At the end of this course, a student will be able to:

COs	Statements	Cognitive Level Mapping

CO1	Recall the history of astronomy in India and abroad until the discovery of universal gravitation.	R
CO2	Distinguish between the different major bodies within the Solar System and summarise their properties.	U
CO3	Apply qualitative physical arguments for the acceptance of the Big Bang and the current Standard Model of cosmology.	A1
CO4	Categorize and outline different open problems in cosmology like dark matter, dark energy, the fate of the Universe, etc.	A2
CO5	Critique important space agencies and significant space missions and probes.	E
CO6	Propose how the gravitational forces and fusion process within stars lead to their evolution as a singular entity and as a group in galaxies.	C

Course Content

Units	Content	Lecture Hours	COs	RBT
Unit I	**A Brief History of Astronomy till 1700 CE** *Astronomy in India:* Astronomy in the *Vedas*, Important Indian astronomers and their contributions *Astronomy outside India:* Brief overview of Babylonian, Hellenistic, Artistotelian, and Greco-Roman astronomy *Birth of modern astronomy:* Astronomy before Copenicus, Heliocentric model of Copernicus; Kepler's laws; Galileo's arguments; Newton and universal gravitation; Basic principles of telescopes	**7**	**1**	**R U A1 A2 E C**
Unit II	**The Solar System** *The Sun:* Structure and properties, Solar phenomena, Solar cycle and its effects on Earth *The Earth and Moon*: Earth - composition and properties, Tectonic plates, Rotation and revolution, The seasons; Moon - composition and properties, Craters, Tides, Phases, Solar and lunar eclipses, Theories of lunar origin;	**8**	**2**	**R U A1 A2 E C**

	Solar, lunar, and lunisolar calendars *The terrestrial planets*: Mercury, Venus and Mars, Possibility of life and human colonization on Mars *The gas giants*: Jupiter and Saturn, Great Red Spot, The Galilean moons, Saturn's Rings and their origin, Titan *The ice giants*: Uranus and Neptune, Rings, Axial tilt of Uranus, Great Dark Spot *Dwarf planets and the outer regions*: The asteroid belt, Meteors and meteorites, Trans-Neptunian objects, Comets, Dwarf planets, The Oort cloud, Planet 9 *The edges of our our existence*: The boundaries of the Solar System, The Voyager missions, Exoplanets			
Unit III	**Stars and Galaxies** *Setting the stage*: Important stars and constellations, Einstein's energy-mass equivalence *The birth and evolution of a star*: Protostars, Brown dwarfs, Main sequence stars, Fusion processes, White dwarfs, Red giants *The "death" of a star*: Supergiants, Supernovae, Neutron stars and pulsars, Black holes and wormholes, The origin and fate of the Solar System *Deciphering objects far away*: Measuring cosmological distances, Morphological types of galaxies and properties *How galaxies behave*: Evolution of galaxies, Clusters and groups, Superclusters, Filaments, Overview of the Milky Way and the Local Group	**11**	**6**	**R U A1 A2 E C**
Unit IV	**Cosmology** *Setting the stage*: Spacetime, Overview of Einstein's special and general relativity, Time	**13**	**3, 4**	**R U A1 A2**

	dilation *The Universe in motion*: Discovery of the expanding Universe, The Big Bang; The formation of matter; The Dark Ages; The first stars and galaxies; The present state of the Universe *What can we detect but not see?* Dark matter and dark energy *How will all things "end"*: The fate of the Universe: Big Crunch, eternal expansion, Big Rip scenarios *Are we alone in the Universe?* The Drake equation, Astrobiology and biosignatures, The Goldilocks zone, Possible candidates in the Solar System and among exoplanets, The Fermi paradox			**E C**
Unit V	**Space Organizations and Missions** *India*: ISRO: History and activities, *Aryabhatta*, *Chandrayaan*, MOM *Abroad*: NASA and ESA: the Hubble Space Telescope, the James Webb Space telescope, the Kepler Telescope, ISS, important telescopes in India and abroad *Space missions and probes*: *Sputnik* I, *Vostok* I, *Apollo* 11, *Soyuz* T-11, *Cassini-Huygens*, *Curiosity*, *New Horizons* (instructor may add or remove topics as they see fit)	**6**	**5**	**R U A1 A2 E C**

Learning Resources:

Text Books

1. Weinberg, S. (2015). *To explain the world: The discovery of modern science*. HarperCollins
2. Fox, K. C. (2002). *The Big Bang theory: What it is, where it came from, and why it works.* Jossey Bass
3. Ouellette, J (2006). *Black bodies and quantum cats: Tales of pure genius and mad science.* Oneworld Publications
4. Comins, N. F., & Kaufmann, W. J. (2005). *Discovering the Universe* (7th ed.). W.H. Freeman & Co.
5. Coles, P. (2014). Cosmology: *A very short introduction*. Oxford University Press

Suggested readings

1. Buchwald, J., & Fox, R. (Eds.). (2017). *The Oxford handbook of the history of physics*. Oxford University Press
2. Simonyi, K. (2012). *A cultural history of physics*. CRC Press

3. Maran, S. (2017). *Astronomy for dummies* (4th ed.). Wiley
4. Chaisson, E., & McMillan, S. (2014). *Astronomy today* (8th ed.). Pearson.
5. Griffiths, D. J. (2012). *Revolutions in Twentieth-century physics*. Cambridge University Press

R: Remembering, U: Understanding, A1: Applying, A2: Analysing, E: Evaluating, C: Creating

2. Assessment

The student **must** score a minimum of 40% of the total maximum marks assigned to the entire paper to pass the course, subject to the following restrictions: (i) the student **must** be present for and score a minimum of 40% in the Summative Assessment, (ii) the student must be present for Formative Assessment II (Mid-Semester Examinations), and (iii) the student should have a **minimum** of 75% attendance for the entire course.

Formative Assessment: 50 marks distributed across three different forms of Assessment. Evaluated as per the Assessment & Evaluation Framework Document of Salesian College.

Summative Assessment:The Summative Assessment will be a written examination of 50 marks of at least 2 hours duration, using the RBT categorization and scheme.

Section	Marks per question	No. of questions to be answered	No. of questions given	Total marks for Section
A	2	5	8	10
B	5	4	6	20
C	10	2	4	20
			Total	**50**

Evaluation Scheme of the entire Course

Component	Marks	Final Weightage	Final Marks
Summative Assessment	50	100%	50
Formative Assessment I	20	50%	10
Formative Assessment II	50		25
Formative Assessment III	20		10
Attendance	5	100%	5
		Total	100

Prepared by:	Checked and verified by:	Approved by:	External Experts - Board of Studies
(Signature) Mr. Bikramjit Chandra	(Signature) Dr. Prajwal Chettri Head of the Department	(Signature) Mr. Subhajit Paul Dean of Sciences	(Signature) Dr. Ranjan Sharma Associate Professor Department of Physics Coochbehar Panchanan Barma University (Signature) Dr. Amitabha Bhattacharyya Associate Professor Department of Physics Sikkim University Gangtok, Sikkim (Signature) Mr. Tamanash Das Supervisor (Retd.) Draughtsman Civil Trade ITI Tollygunge Kolkata (Signature) Mr. Aaush Pradhan (Alumnus) 2018 batch

23PHYVAC101 - Quantum Crossroads I

2. Course Description

Course Code	23PHYVAC101
Course Title	Quantum Crossroads I
Credits	1
Total Hours	30
Hours per Week	2
Course Type	Value Added Course
Semester	I
Intended Level	Certificate
Issue(s) Addressed	
Course Offered to	Physics
Regulation	2023
Course Overview	This course: a. Trains a student to plan, rehearse and present technical and mathematical information to an audience of their peers b. Provides students with an avenue to express technical information in an academic or professional environment. c. Trains students to comport themselves vocally and physically while presenting in front of an audience. d. Teaches students the use of digital aids such as slideshow software and projectors for the use of dissemination of information.
Prerequisite	Students must be majoring in Physics. Students must have a reasonable command of English
Course Objectives	A student will be able to: i. Read and understand technical information from a paper, article or other specialized manuals. ii. Analyze and break down the given information and assimilate with pre-existing knowledge. iii. Construct and present technical knowledge to an audience of their peers in a clear and lucid manner. iv. Critically evaluate and argue for or against the thesis of the paper.

Course Outcomes based on RBT and Cognitive Level Mapping
At the end of this course, a student will be able to:

COs	Statements	Cognitive Level Mapping
CO1	Describe the details of the paper being presented	R
CO2	Interpret the paper and relate it to their pre-existing knowledge	U
CO3	Present the knowledge in a clear and lucid manner to an audience of their peers	A1

CO4	Appraise and break down the information being presented.	A2
CO5	Critique and argue for or against the thesis of the paper.	E
CO6	Design and construct a presentation that disseminates knowledge from the paper to an audience.	C

Course Structure

Session Number	Content	Total Hours	COs	RBT
1	Hours 1 & 2: Introduction to the Course	**2**	**-**	**-**
2-10	Hour 1: Presentation by one 3rd year student Hour 2: Summarized report on the presentation	**18**	**1,2,4**	**R U A2 E**
11	Hour 1: Demo presentation by faculty Hour 2: Report on demo presentation	**2**	**1,2,4**	**R U A2 E**
12-14	Hour 1: Learning Google Slides and on using Google Scholar Hour 2: Practical class for the same	**6**	**1,2,4**	**R U A2 E**
15	Hour 1: How to present oneself in front of an audience Hour 2: Practice session for the same	**2**	**3**	**A1 C**

Learning Resources:
None

R: Remembering, U: Understanding, A1: Applying, A2: Analysing, E: Evaluating, C: Creating

2. Assessment

The student **must** score a minimum of 40% of the total maximum marks assigned to the entire paper to pass the course, subject to the following restrictions: (i) the student **must** submit the final report for Summative Assessment, and (ii) the student should have a **minimum** of 75% attendance for the entire course.

Formative Assessment: Students have to present a written report for each presentation that they attend, and also write reports for all the practical work done in the tutorial classes. Each report will be graded out of 10 and finally converted to a fraction of 20 marks.

Summative Assessment:The Summative Assessment will be a final assignment of 25 marks.

Evaluation Scheme of the entire Course

Component	Marks	Final Weightage	Final Marks
Summative Assessment	25	100%	25

Formative Assessment	10 times the number of reports	variable	20
Attendance	5	100%	5
		Total	50

Prepared by:	**Checked and verified by:**	**Approved by:**	**External Experts -** **Board of Studies**
(Signature) Mr. Bikramjit Chandra	(Signature) Dr. Prajwal Chettri Head of the Department	(Signature) Mr. Subhajit Paul Dean of Sciences	(Signature) Dr. Ranjan Sharma Associate Professor Department of Physics Coochbehar Panchanan Barma University (Signature) Dr. Amitabha Bhattacharyya Associate Professor Department of Physics Sikkim University Gangtok, Sikkim (Signature) Mr. Tamanash Das Supervisor (Retd.) Draughtsman Civil Trade ITI Tollygunge Kolkata (Signature) Mr. Aaush Pradhan (Alumnus) 2018 batch

SEMESTER – II

23PHYMAJ103 - Electricity and Magnetism

2. Course Description

Course Code	23PHYMAJ103
Course Title	Electricity and Magnetism
Credits	4
Total Hours	75
Hours per Week	5
Course Type	Major
Semester	II
Intended Level	Certificate
Issue(s) Addressed	
Course Offered to	Physics
Regulation	2023
Course Overview	This course: a. The course focuses on the distribution of fields near static electric charge configurations. It gives the students a basic understanding of conductors, dielectrics, polarization, and electrostatic energy. b. It helps to introduce the students to magnetic force, steady current, and magnetic phenomena. It aims to help understand the fundamentals of magnetization in matter and assess the magnetic properties of materials. c. It teaches the basics of electromagnetic induction due to time-varying fields and magnetostatic energy. d. It focuses on understanding the behaviour of the electric and magnetic fields in an electromagnetic wave.
Prerequisite	Students must have an introductory knowledge of electrostatics, magnetostatics, and electrodynamics. Students must have completed the PHYMAJ101 course
Course Objectives	A student will be able to: i. Understanding the basic properties of static electricity and applying their concepts and mathematical techniques to different cases. ii. Applications of electrostatics in conductors and dielectrics, such as capacitors, and their practical uses. iii. Understand the causes of magnetic phenomena and their properties, such as the Biot-Savart law, Ampere's law, etc. iv. Applications of magnetic properties to matter such as susceptibility, permeability, etc. v. Identifying the connection between electricity & magnetism and allied phenomena such as electromagnetic induction. vi. Studying electromagnetic theory using Maxwell's equations and applying it to electromagnetic waves in different media.
Course Outcomes based on RBT and Cognitive Level Mapping	

At the end of this course, a student will be able to:				
COs	**Statements**	**Cognitive Level Mapping**		
CO1	Define the electric field & electric potential and describe the relation of electrostatics to various aspects of electrical charge.	R		
CO2	Explain the concepts of electromagnetic induction and its applications.	U		
CO3	Calculate the magnetic field, magnetic vector potential and energy stored for various steady-current carrying systems using various methods.	A1		
CO4	Examine the wave equations from Maxwell's equations for different media and categorize the electromagnetic waves & their properties.	A2		
CO5	Evaluate various types of magnetism, such as dia-, para-, and ferro-magnetism, and draw conclusions on their properties.	E		
CO6	Formulate the electric field, electric potential, and energy stored for discrete and continuous charge systems using suitable methods.	C		
Course Content				
Units	**Content**	**Lecture Hours**	**COs**	**RBT**
Unit I	**Electric Field and Electric Potential:** Electric field: Electric field lines. Electric flux. Coulomb's law. Gauss' Law with applications to charge distributions with spherical, cylindrical and planar symmetry. Conservative nature of Electrostatic Field. Electrostatic Potential. Laplace's and Poisson equations. **Electrostatic boundary value problem and Method of Images:** Uniqueness theorem, Laplace's equation , Method of images.	**12**	**1**	**R U A1 A2 E C**

Unit II	**Electrostatics in Conductors and Dielectrics:** Conductors and Dielectrics, Electric Dipole, Dielectric Polarization, Gauss's law in Dielectric medium, Boundary Conditions. **Electrostatic Energy and Capacitor:** Electrostatic energy of a system of charged conductors, capacitors and their combinations, energy stored in a charged capacitor.	**10**	**6**	**R U A1 A2 E C**
Unit III	**Magnetic Field:** Magnetic force between current elements and definition of Magnetic Field B. Biot-Savart's Law and its simple applications: straight wire and circular loop. Current Loop as a Magnetic Dipole and its Dipole Moment. Ampere's Circuital Law and its application to (1) infinite straight wire, (2) Infinite planar surface current and (3) Solenoid. Properties of B: curl and divergence. Axial vector property of B and its consequences. Magnetic Vector Potential. Magnetic Force on (1) point charge (2) current carrying wire (3) between current elements. Torque on a current loop in a uniform Magnetic Field. Magnetic Scalar Potential.	**8**	**2**	**R U A1 A2 E C**
Unit IV	**Magnetic Properties of Matter:** Magnetization vector (M). Magnetic Intensity (H). Magnetic Susceptibility and permeability. Relation between B, H, M. Comparison of Dia-, Para- and Ferromagnetism. B-H curve and hysteresis loss.	**5**	**3**	**R U A1 A2 E C**
Unit V	**Electromagnetic Induction:** Faraday's law. Self-Inductance and Mutual Inductance. Neumann's Formula. Reciprocity Theorem. Energy stored in a Magnetic Field. **Electromagnetic Theory:** Maxwell's equations, Poynting's vector and Poynting's theorem. Wave equation in free space, dielectric medium and conducting medium. Polarization of plane electromagnetic waves, Methods of producing plane polarized light: simple reflection, double reflection and dichroism, Malus law.	**10**	**4, 5**	**R U A1 A2 E C**
Learning Resources:				

Text Books

1. Ghosh, B. (2008). *Foundations of electricity and magnetism* (3rd rev. ed.). Books & Allied (P) Limited
2. Murugeshan, R. (2019). *Electricity and magnetism* (10th ed.). S. Chand & Co.
3. Griffiths, D. J. (2015). *Introduction to electrodynamics* (4th ed.). Cambridge University Press
4. Sadiku, M. N. O. (2018). *Elements of electromagnetics* (7th ed.). Oxford University Press
5. Subrahmanyam, N., Lal, B., & Avadhanulu, M. N. (2006). *A textbook of optics* (23rd rev. ed.). S. Chand & Co.
6. Gupta, A. B. (2013). *Modern optics* (3rd ed.). Books & Allied (P) Limited

Suggested readings

1. Purcell, E. M., & Morin, D. J. (2013). *Electricity and magnetism* (3rd ed.). Cambridge University Press
2. Manohara, S. R., & Shubha A. (2018). *Electricity, magnetism and electromagnetic theory*. S. Chand & Co.

R: Remembering, U: Understanding, A1: Applying, A2: Analysing, E: Evaluating, C: Creating

Practicals

Course Code	23PHYMAJ103
Course Title	Electricity and Magnetism
Credits	4
Total Hours	75
Hours per Week	5
Course Type	Major
Semester	II
Intended Level	Certificate
Issue(s) Addressed	
Course Offered to	Physics
Regulation	2023
Course Overview	This course: a. The course provides the knowledge to measure various physical quantities through a scientific approach. b. It aims to help in estimating various electric and magnetic properties of materials using scientific apparatus. c. It focuses on giving training in the use of precision measurements, calibration, and error analysis.
Prerequisite	Students must have an introductory knowledge of electrostatics, magnetostatics, and electrodynamics. Students must have completed the PHYMAJ101 course
Course Objectives	A student will be able to: i. Enabling the students to determine unknown resistances by applying the principles of the potentiometer and Carey Foster's bridge.

	ii. Enabling students to compute magnetic field strength and its gradient and determine energy losses from the hysteresis. iii. Enabling students to produce and detect plane polarized light and graphically construct patterns to prove polarization laws. iv. Enabling students to analyze plane polarized light and to map it graphically v. Enabling students to record experimental data in a systematic manner and hence construct the experiment report on paper. vi. Computing experimental results from the working formulae and graphs and interpreting the results.

Course Outcomes based on Dave's Psychomotor Mapping
At the end of this course, a student will be able to:

COs	Statements	Cognitive Level Mapping
CO1	Replicate the steps required to familiarize themselves with experiments and instruments related to the study of electricity and magnetism.	I
CO2	Recreate any previously imitated experiment on the study of electricity and magnetism.	M
CO3	Demonstrate skilled use of common measuring instruments such as galvanometers, Wheatstone bridges, polarizers, etc.	P
CO4	Be proficient in the setup and use of experimental apparatus used for the study of electricity and magnetism.	P
CO5	Adapt or modify previously imitated experiments to analyze new properties from electricity and magnetism.	A

Course Content

Units	Content	Lecture Hours	COs	Dave's
Unit I	**List of Experiments:** 1. To determine an unknown Low Resistance using Potentiometer. 2. To determine an unknown Low Resistance using Carey Foster's Bridge. 3. Measurement of field strength B and its variation in a solenoid (determine dB/dx)	**30**	**1, 2, 3,4,5**	**I M P A**

	4. To determine self-inductance of a coil by Anderson's bridge. 5. To study polarization of light by reflection and determine the polarizing angle for air-glass interface. 6. To verify Malus law for plane polarized light. 7. To draw the BH curve of Fe using Solenoid & determine energy loss from Hysteresis. 8. To verify Brewster's law for plane polarized light. 9. To determine internal resistance of a cell using (a) potentiometer and (b) voltmeter & ammeter. 10. To measure large EMF by means of a potentiometer. ***A minimum of EIGHT (8) experiments is to be performed***			
Learning Resources: Text Books 1. Chattopadhyay, D., & Rakshit, P. C. (2011). *An advanced course in practical physics*. New Central Book Agency (P) Limited 2. Raychaudhuri, D. P. (n.d.). *Manual of practical physics*. Allied Book Agency 3. Dasgupta, C.R. (1985). *A handbook of practical physics*. Book Syndicate Private Limited 4. Singh, H., & Hemne, P.S. (2022). *B.Sc. practical physics*. S. Chand & Co.				

2. Assessment

The student **must** score a minimum of 40% of the total maximum marks assigned to the entire paper to pass the course, subject to the following restrictions: (i) the student **must** be present for and score a minimum of 40% in the Summative Assessment for theory and practical **each**, (ii) the student must be present for Formative Assessment II (Mid-Semester Examinations), and (iii) the student should have a **minimum** of 75% attendance for the entire course.

Formative Assessment: 50 marks distributed across three different forms of Assessment. Evaluated as per the Assessment & Evaluation Framework Document of Salesian College.

Summative Assessment (Theory):The Summative Assessment will be a written examination of 50 marks of at least 2 hours duration, using the RBT categorization and scheme.

Section	Marks per question	No. of questions to be answered	No. of questions given	Total marks for Section
A	2	5	8	10
B	5	4	6	20
C	10	2	4	20
			Total	**50**

Summative Assessment (Practical):The Summative Assessment will be an examination of 50 marks of at least 3 hours duration. The student will be made to perform one or more experiments chosen at random from the topics given in the syllabus.

Sl. No.	Component	Marks per component
1	Practical Examination	30
2	Viva-voce	10
3	Lab notebook or Lab assignment	10
	Total	**50**

Evaluation Scheme of the entire Course

Component	Marks	Final Weightage	Final Marks
Summative Assessment (Theory)	50	50%	25
Summative Assessment (Practical)	50		25
Formative Assessment I	20		10
Formative Assessment II	50		25
Formative Assessment III	20		10
Attendance	5	100%	5
		Total	100

Prepared by:	Checked and verified by:	Approved by:	External Experts - Board of Studies
(Signature) Ms. Sujata Sinha (Signature) Dr. Digvijay Kharga	(Signature) Dr. Prajwal Chettri Head of the Department	(Signature) Mr. Subhajit Paul Dean of Sciences	(Signature) Dr. Ranjan Sharma Associate Professor Department of Physics Coochbehar Panchanan Barma University (Signature) Dr. Amitabha Bhattacharyya Associate Professor Department of Physics Sikkim University Gangtok, Sikkim (Signature) Mr. Tamanash Das Supervisor (Retd.) Draughtsman Civil Trade ITI Tollygunge Kolkata (Signature) Mr. Aaush Pradhan (Alumnus) 2018 batch

23PHYMAJ104 - Waves and Optics

3. Course Description

Course Code	23PHYMAJ104
Course Title	Waves and Optics
Credits	4
Total Hours	75
Hours per Week	5
Course Type	Major
Semester	II
Intended Level	Certificate
Issue(s) Addressed	
Course Offered to	Physics
Regulation	2023
Course Overview	This course: a. The course helps students get familiarised with important aspects of waves and oscillations and hence study different optical phenomena. b. It helps students study the nature of waves in a generic manner. c. It helps students describe the course of waves through different materials. d. It makes students acquainted with the history of development of light, with brevity. e. It helps students describe different optical phenomena like interference and diffraction. f. It helps the students to build a strong background for different experiments. g. It bolsters the drawing skills (ray diagrams, experimental setups, fringe patterns, etc.) of the students.
Prerequisite	Students must have an introductory knowledge of oscillations, waves, superpositions, and light. Students must have completed the PHYMAJ101 and MATMIN101 courses.
Course Objectives	A student will be able to: i. Introduce the basic concepts of superposition principle, Lissajous figures, wave motion, coherence, interference, and diffraction phenomena. ii. Apply the superposition principle and Huygen's principle to explain important phenomena in waves and optics. iii. Describe the workings of interferometers and judge their relative importance in physics. iv. Explain the motion of waves in different media with the help of key concepts and mathematics. v. Draw and explain interference and diffraction patterns.

	vi. Explain the setup for important experiments like Melde's experiment and Young's double-slit experiments, and hence describe the significance of the results.

Course Outcomes based on RBT and Cognitive Level Mapping
At the end of this course, a student will be able to:

COs	Statements	Cognitive Level Mapping
CO1	Describe waves of various kinds and their properties in terms of differential equations and their solutions.	R
CO2	Summarize the wave theory of light and explain the concept of waveguides.	U
CO3	Apply the concept of fringe formation and calculate the wavelength of light.	A1
CO4	Differentiate between interference and diffraction phenomena of light.	A2
CO5	Select optical instruments such as standard light sources, spectrometers, grating, slits, etc. for the purpose of evaluating various optical properties.	E
CO6	Use the superposition principle to formulate the resultant displacement in various kinds of physical situations.	C

Course Content

Units	Content	Lecture Hours	COs	RBT
Unit I	**Superposition of Harmonic oscillations** **Collinear:** Linearity and Superposition Principle. Superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies (Beats). Superposition of N collinear Harmonic Oscillations with (1) equal phase differences and (2) equal frequency differences. **Perpendicular:** Graphical and Analytical	**7**	**1, 3, 6**	**R U A1 A2 E C**

	Methods. Lissajous Figures with equal and unequal frequency and their uses.			
Unit II	**Wave Motion** Plane and Spherical Waves. Longitudinal and Transverse Waves. Plane Progressive (Travelling) Waves. Wave Equation. Particle and Wave Velocities. Differential Equation. Pressure of a Longitudinal Wave. Energy Transport. Intensity of Wave. Water Waves: Ripple and Gravity Waves **Velocity of Waves** Velocity of Transverse Vibrations of Stretched Strings. Velocity of Longitudinal Waves in a Fluid in a Pipe. Newton's Formula for Velocity of Sound. Laplace's Correction.	**8**	**1,2,3, 5, 6**	**R U A1 A2 E C**
Unit III	**Superposition of Two Harmonic Waves** Standing (Stationary) Waves in a String: Fixed and Free Ends. Analytical Treatment. Phase and Group Velocities. Changes with respect to Position and Time. Energy of Vibrating String. Transfer of Energy. Normal Modes of Stretched Strings. Plucked and Struck Strings. Melde's Experiment. Longitudinal Standing Waves and Normal Modes. Open and Closed Pipes. Superposition of N Harmonic Waves.	**7**	**1,3,4**	**R U A1 A2 E C**
Unit IV	**Nature of Light** A brief history of light, the corpuscular and wave theories of light, electromagnetic nature of light (qualitative discussions only), Definition and properties of wave front. Huygens Principle. Temporal and Spatial Coherence. **Introduction to Interference:** Coherence (brief qualitative discussion), Young's double-slit experiment - derivation of fringe width, conditions for observable interference **Interference by Division of Wavefront:** Fresnel's Biprism - qualitative analysis of fringe pattern, applications (determine of unknown wavelength and thickness of thin sheet); interference with white light	**14**	**3,4,5, 6**	**R U A1 A2 E C**

	Interference by Division of Amplitude: Stokes' treatment, interference in thin films (wedge-shaped and parallel films), Newton's rings - analysis of interference pattern and applications **Interferometers:** The Michelson Interferometer - qualitative discussions on construction, formation of fringes and importance in physics; determination of wavelength of light			
Unit V	**Diffraction of Light** **Introduction to Diffraction:** Interference versus Diffraction, Classification of Diffraction types **Fraunhofer Type Diffraction:** Single slit and double slit diffraction - qualitative discussions on diffraction pattern and positions of maxima and minima;the theory of plane transmission grating; resolving and dispersive power of a grating **Fresnel Type Diffraction:** Fresnel's half period zones, zone plate theory, comparison between zone plate and convex lens, diffraction at a: circular aperture and thin wire (only qualitative discussion of the fringe patterns)	**9**	**3, 4, 5**	**R U A1 A2 E C**

Learning Resources:

Text Books

1. Ghatak, A. (2017). *Optics* (6th ed). McGraw Hill Education (India)
2. Gupta, A. B. (2013). *Modern optics* (4th ed.). Books and Allied (P) Ltd.
3. Bajaj, N. K. (2017). *The physics of waves and oscillations*. Tata McGraw-Hill
4. Chaudhuri, R. N. (2010). *Waves and oscillations* (2nd ed.). New Age International Publishers
5. Chattopadhyay, D., & Rakshit, P. C. (2011). *Vibrations, waves and acoustics*. Books & Allied (P) Ltd.
6. Jenkins, F. A. & White, H. E. (2017). *Fundamentals of optics* (4th Indian ed.). McGraw Hill Education.

Suggested readings

1. Parthasarathy, H. (2019). *Waves and optics*. CRC Press
2. Hecht, E. (2019). *Optics*. Pearson
3. Kumar, A., Gulati, H. R. & Khanna, D. R. (n.d.). *Fundamentals of optics*. R. Chand Publications
4. Pain, H. J. (2006). *The physics of vibrations and waves* (6th ed.). John Wiley and Sons

R: Remembering, U: Understanding, A1: Applying, A2: Analysing, E: Evaluating, C: Creating

Practicals

Course Code	23PHYMAJ203
Course Title	Waves and Optics
Credits	4
Total Hours	75
Hours per Week	5
Course Type	Major
Semester	II
Intended Level	Certificate
Issue(s) Addressed	
Course Offered to	Physics
Regulation	2023
Course Overview	This course: a. The course helps students get acquainted with different instruments (especially pertinent to the experiments of optics) and their applications and limitations. b. It emphasises the necessity of hands-on experience with the measurement of physical quantities and understanding theoretical concepts through experiments. c. It aims to help in estimating the quantifiers and studying important properties related to different optical phenomena through experiments. d. It aims to help study important properties of waves and oscillations through experiments. e. It aims to make students accustomed to working in the dark room (for optics experiments only).
Prerequisite	Students must have an introductory knowledge of oscillations, waves, superpositions, and light. Students must have completed the PHYMAJ101 and MATMIN101 courses.
Course Objectives	A student will be able to: i. Enabling students to identify the important parts of an instrument and understand the significance of the constants of an instrument. ii. Setting up the experiment by properly assorting important components. iii. Enabling the students to record experimental data in a systematic manner and hence construct the experiment report on paper. iv. Computing the experimental results mathematically from the graphs with the help of a working formula. v. Making visual representations of the experimental data, wherever necessary (primarily graphs), and hence interpreting the results.

	vi. Nurturing the scientific temperament among the students and encouraging them to reflect on their personal experiences of conducting the experiments.			
Course Outcomes based on Dave's Psychomotor Mapping At the end of this course, a student will be able to:				
COs	**Statements**	**Cognitive Level Mapping**		
CO1	Replicate the steps required to familiarize themselves with experiments and instruments related to the study of waves and optics.	I		
CO2	Recreate any previously imitated experiment on the study of waves and optics.	M		
CO3	Demonstrate skilled use of common measuring instruments such as spectrometers, light sources, lasers, gratings, etc.	P		
CO4	Be proficient in the setup and use of experimental apparatus used for the study of waves and optics.	P		
CO5	Adapt or modify previously imitated experiments to analyze new properties from waves and optics.	A		
Course Content				
Units	**Content**	**Lecture Hours**	**COs**	**Dave's**
Unit I	**List of Experiments:** 1. To determine the velocity of sound through a wire using sonometer 2. To study Lissajous Figures (with phase analyses for different phases) 3. To verify the laws of transverse vibrations using Melde's apparatus 4. To determine the frequency of an electric tuning fork by Melde's experiment and verify the square of wavelength - time period law 5. To study the vibration of guitar strings 6. To determine the angle of a prism	**30**	**1, 2, 3,4,5**	**I M P A**

	7. To determine the refractive index of material of a prism using a sodium source 8. To determine the dispersive power and Cauchy constants of the material of a prism using a mercury source 9. To determine the wavelength of sodium light using Fresnel's Biprism 10. To determine the wavelength of sodium light using Newton's Rings method 11. To determine the refractive index of a liquid using Newton's Rings method 12. To determine the wavelength of a laser source using single slit diffraction 13. To determine the wavelength of (a) sodium light and (b) spectral lines of mercury source using a plane diffraction grating 14. To study the diffraction at a straight wire. ***A minimum of EIGHT (8) experiments is to be performed***			

Learning Resources:
Text Books

1. Chattopadhyay, D., & Rakshit, P. C. (2011). *An advanced course in practical physics*. New Central Book Agency (P) Limited
2. Raychaudhuri, D. P. (n.d.). *Manual of practical physics*. Allied Book Agency
3. Dasgupta, C.R. (1985). *A handbook of practical physics*. Book Syndicate Private Limited
4. Singh, H., & Hemne, P.S. (2022). *B.Sc. practical physics*. S. Chand & Co.

2. Assessment

The student **must** score a minimum of 40% of the total maximum marks assigned to the entire paper to pass the course, subject to the following restrictions: (i) the student **must** be present for and score a minimum of 40% in the Summative Assessment for theory and practical **each**, (ii) the student must be present for

Formative Assessment II (Mid-Semester Examinations), and (iii) the student should have a **minimum** of 75% attendance for the entire course.
Formative Assessment: 50 marks distributed across three different forms of Assessment. Evaluated as per the Assessment & Evaluation Framework Document of Salesian College.

Summative Assessment (Theory):The Summative Assessment will be a written examination of 50 marks of at least 2 hours duration, using the RBT categorization and scheme.

Section	Marks per question	No. of questions to be answered	No. of questions given	Total marks for Section
A	2	5	8	10
B	5	4	6	20
C	10	2	4	20
			Total	**50**

Summative Assessment (Practical):The Summative Assessment will be an examination of 50 marks of at least 3 hours duration. The student will be made to perform one or more experiments chosen at random from the topics given in the syllabus.

Sl. No.	Component	Marks per component
1	Practical Examination	30
2	Viva-voce	10
3	Lab notebook or Lab assignment	10
	Total	**50**

Evaluation Scheme of the entire Course

Component	Marks	Final Weightage	Final Marks
Summative Assessment (Theory)	50	50%	25
Summative Assessment (Practical)	50		25
Formative Assessment I	20		10
Formative Assessment II	50		25

Formative Assessment III	20		10
Attendance	5	100%	5
		Total	100

Prepared by:	**Checked and verified by:**	**Approved by:**	**External Experts -** **Board of Studies**
(Signature) Dr. Prajwal Chettri (Signature) Mr. Mayukh Mazumdar	(Signature) Dr. Prajwal Chettri Head of the Department	(Signature) Mr. Subhajit Paul Dean of Sciences	(Signature) Dr. Ranjan Sharma Associate Professor Department of Physics Coochbehar Panchanan Barma University (Signature) Dr. Amitabha Bhattacharyya Associate Professor Department of Physics Sikkim University Gangtok, Sikkim (Signature) Mr. Tamanash Das Supervisor (Retd.) Draughtsman Civil Trade ITI Tollygunge Kolkata (Signature) Mr. Aaush Pradhan (Alumnus) 2018 batch

23PHYSEC102 - Practical Electricity

4. Course Description

Course Code	23PHYSEC102
Course Title	Practical Electricity
Credits	3
Total Hours	60
Hours per Week	4
Course Type	Skill Enhancement Course
Semester	II
Intended Level	Certificate
Issue(s) Addressed	
Course Offered to	Physics
Regulation	2023
Course Overview	This course: a. The course aims to provide knowledge on practical electrical circuits. b. The students will have an understanding of application of resistors, inductors and capacitors in circuits. c. Students will learn maintenance practices for electrical equipment and systems. d. Students will learn the importance of electrical safety practices, including proper grounding, insulation, and handling of electrical hazards. e. Students will develop skills in diagnosing and troubleshooting electrical problems in circuits and systems.
Prerequisite	Students must have an introductory knowledge of electromagnetic theory and electric circuits. Students must be taking PHYMAJ103 concurrently
Course Objectives	A student will be able to: i. Understanding the basic concepts and laws of electrical circuits, such as voltage, current, resistance, Ohm's Law, etc., and their applications. ii. Developing techniques to analyze and solve electrical circuits such as Kirchhoff's laws, nodal analysis, and mesh analysis. iii. Identifying and understanding the characteristics of active and passive electrical components and analyzing the transient and steady-state responses of circuits. iv. Understanding the principles of electrical power generation, transmission, and distribution along with different types of electrical systems, such as single-phase and three-phase systems. v. Introducing the student to electrical codes, standards, and regulations related to wiring and electrical installations. vi. Understanding the principles of electrical safety and the importance of following proper procedures.
Course Outcomes based on RBT and Cognitive Level Mapping	

At the end of this course, a student will be able to:				
COs	**Statements**	**Cognitive Level Mapping**		
CO1	Identify and recall the basic concepts and laws of electrical circuits, such as voltage, current, resistance, Ohm's Law, etc., and their applications.	R		
CO2	Summarize the principles of electrical power generation, transmission, and distribution along with different types of electrical systems, such as single-phase and three-phase systems.	U		
CO3	Apply techniques of analysis such as Kirchhoff's laws, nodal analysis, mesh analysis, etc., to calculate electrical circuit parameters.	A1		
CO4	Analyze various active and passive electrical components and investigate their characteristics and behaviour in electric circuits.	A2		
CO5	Recommend and argue for the correct procedure to implement in accordance with the principles of electrical safety.	E		
CO6	Propose and correctly interpret the various standards related to electrical codes and regulations related to wiring and electrical installations.	C		
Course Content				
Units	**Content**	**Lecture Hours**	**COs**	**RBT**
Unit I	**Basic Electricity Principles** Voltage, Current, Resistance, and Power. Ohm's law. Series, parallel, and series-parallel combinations. Ammeters, voltmeters, galvanometers and conversion of galvanometer to either instrument. AC Electricity and DC Electricity. Ideal Constant-voltage and Constant-current Sources.	**6**	**1, 4**	**R U A1 A2 E C**
Unit II	**Electrical Circuits** AC Circuits: Kirchhoff's laws for AC circuits. Resistors, inductors and capacitors. Diode and rectifiers. Components in Series or in shunt.	**8**	**1, 3, 4**	**R U A1 A2**

	Response of inductors and capacitors with DC and AC sources. DC circuit theory: Kirchhoff's laws for DC circuits, voltage division, current division, Y (Wye)-delta transformations. RC and RL in DC circuits. Complex Reactance and Impedance. Series LCR Circuit: (1) Resonance, (2) Power Dissipation and (3) Quality Factor, and (4) Band Width. Parallel LCR Circuit			**E C**
Unit III	**Network theorems** Network Theorems: Thevenin theorem, Norton theorem, Superposition theorem, Reciprocity theorem, Maximum Power Transfer theorem. Applications to dc circuits.	**5**	**3**	**R U A1 A2 E C**
Unit IV	**Generators, Motors and Transformers** DC Power sources. AC/DC generators. Single-phase, three-phase & DC motors. Basic design. Speed & power of ac motor Operation of transformers.	**5**	**1,6**	**R U A1 A2 E C**
Unit V	**Electrical Protection** Relays. Fuses and disconnect switches. Circuit breakers. Overload devices. Ground-fault protection. Grounding and isolating. Phase reversal. Surge protection. Interfacing DC or AC sources to control elements (relay protection device)	**6**	**5,6**	**R U A1 A2 E C**

Learning Resources:

Text Books

1. Mahajan, S., & Choudhury, S. R. (2017). *Electricity, magnetism and electromagnetic theory*. Tata McGraw-Hill
2. Yarwood, J. (1973). *Electricity and magnetism*. University Tutorial Press. https://archive.org/details/electricitymagne0000yarw/page/n7/mode/2up
3. Say, M. G. (2002). *Performance and design of alternating current machines* (3rd ed.). CBS Publishers and Distributors.
4. Theraja, B. L., Theraja, A. K., & Tarnekar, S. G. (2019). *A textbook of electrical technology: Basic electrical engineering* (Volume 1) (23rd rev. ed.). S Chand & Co.
5. Theraja, B. L., Theraja, A. K., & Tarnekar, S. G. (2019). *A textbook of electrical technology: AC & DC machines* (Volume 2) (23rd rev. ed.). S Chand & Co.
6. Purcell, E. M., & Morin, D. J. (2013) *Electricity and magnetism* (3rd ed.). Cambridge University Press

R: Remembering, U: Understanding, A1: Applying, A2: Analysing, E: Evaluating, C: Creating

Practicals

Course Code	23PHYSEC102
Course Title	Practical Electricity
Credits	3
Total Hours	60
Hours per Week	4
Course Type	Skill Enhancement Course
Semester	II
Intended Level	Certificate
Issue(s) Addressed	
Course Offered to	Physics
Regulation	2023
Course Overview	This course: 1. The course helps students get acquainted with different circuit components. 2. It focuses on hands-on experience with the measurement of physical quantities and understanding theoretical concepts through experiments. 3. It aims to help in studying important properties related to transient phenomena of electricity through experiments.
Prerequisite	Students must have an introductory knowledge of electromagnetic theory and electric circuits. Students must be taking PHYMAJ103 concurrently
Course Objectives	A student will be able to: i. Studying the characteristics of circuit components. ii. Proving the network theorems experimentally. iii. Analyzing and understanding the characteristics of series and parallel LCR circuits. iv. Learning about electrical protection components. v. Constructing a motion sensor for the operation of an automatic lighting system. vi. Construct a single phase DC motor and to find the average power generated by the motor.

Course Outcomes based on Dave's Psychomotor Mapping
At the end of this course, a student will be able to:

COs	Statements	Cognitive Level Mapping
CO1	Replicate the steps required to familiarize themselves with experiments and instruments related to the study of electric circuits.	I
CO2	Recreate any previously imitated experiment on the study of electric circuits.	M
CO3	Demonstrate skilled use of common electrical instruments such as multimeters, relays, bread boards, etc.	P

CO4	Be proficient in the setup and use of experimental apparatus used for the study of electric circuits.	P		
CO5	Adapt or modify previously imitated experiments to analyze new properties from electric circuits.	A		
Course Content				
Units	**Content**	**Lecture Hours**	**COs**	**Dave's**
Unit I	**List of Experiments:** 1. To study the characteristics of a series RC Circuit. 2. To verify the Thevenin and Norton theorems. 3. To verify the Superposition, and Maximum power transfer theorems. 4. To study the response curve of a Series LCR circuit and determine its (a) Resonant frequency, (b) Impedance at resonance, (c) Quality factor Q, and (d) Band width. 5. To study the response curve of a parallel LCR circuit and determine its (a) Anti- resonant frequency and (b) Quality factor Q. 6. To construct a single phase DC motor and to find the average power generated by the motor. 7. To construct a relay alarm in case of an overloaded circuit. 8. To construct a motion sensor for the operation of an automatic lighting system. 9. To calibrate voltmeter and ammeter using potentiometer.	**30**	**1, 2, 3,4,5**	**I M P A**

Learning Resources:

Text Books

1. Chattopadhyay, D., & Rakshit, P. C. (2011). *An advanced course in practical physics*. New Central Book Agency (P) Limited
2. Raychaudhuri, D. P. (n.d.). *Manual of practical physics*. Allied Book Agency
3. Dasgupta, C.R. (1985). *A handbook of practical physics*. Book Syndicate Private Limited
4. Singh, H., & Hemne, P.S. (2022). *B.Sc. practical physics*. S. Chand & Co.

2. Assessment

The student **must** score a minimum of 40% of the total maximum marks assigned to the entire paper to pass the course, subject to the following restrictions: (i) the student **must** be present for and score a minimum of 40% in the Summative Assessment for theory and practical **each**, (ii) the student must be present for Formative Assessment II (Mid-Semester Examinations), and (iii) the student should have a **minimum** of 75% attendance for the entire course.

Formative Assessment: 50 marks distributed across three different forms of Assessment. Evaluated as per the Assessment & Evaluation Framework Document of Salesian College.

Summative Assessment (Theory):The Summative Assessment will be a written examination of 50 marks of at least 2 hours duration, using the RBT categorization and scheme.

Section	Marks per question	No. of questions to be answered	No. of questions given	Total marks for Section
A	2	5	8	10
B	5	4	6	20
C	10	2	4	20
			Total	**50**

Summative Assessment (Practical):The Summative Assessment will be an examination of 50 marks of at least 3 hours duration. The student will be made to perform one or more experiments chosen at random from the topics given in the syllabus.

Sl. No.	Component	Marks per component
1	Practical Examination	30

2	Viva-voce	10
3	Lab notebook or Lab assignment	10
	Total	**50**

Evaluation Scheme of the entire Course

Component	Marks	Final Weightage	Final Marks
Summative Assessment (Theory)	50	50%	25
Summative Assessment (Practical)	50		25
Formative Assessment I	20		10
Formative Assessment II	50		25
Formative Assessment III	20		10
Attendance	5	100%	5
		Total	100

Prepared by:	Checked and verified by:	Approved by:	External Experts - Board of Studies
(Signature) Ms. Sujata Sinha (Signature) Dr. Prajwal Chettri	(Signature) Dr. Prajwal Chettri Head of the Department	(Signature) Mr. Subhajit Paul Dean of Sciences	(Signature) Dr. Ranjan Sharma Associate Professor Department of Physics Coochbehar Panchanan Barma University (Signature) Dr. Amitabha Bhattacharyya Associate Professor Department of Physics Sikkim University Gangtok, Sikkim (Signature) Mr. Tamanash Das Supervisor (Retd.) Draughtsman Civil Trade ITI Tollygunge Kolkata (Signature) Mr. Aaush Pradhan (Alumnus) 2018 batch

23PHYMIN102 - Mechanics

5. Course Description

Course Code	23PHYMIN102
Course Title	Mechanics
Credits	4
Total Hours	75
Hours per Week	5
Course Type	Major
Semester	II
Intended Level	Certificate
Issue(s) Addressed	
Course Offered to	Students not from Physics
Regulation	2023
Course Overview	This course: a. The course aims to train the students in the basic knowledge of Physics, and the laws governing it. b. It helps to introduce the students to conservation laws and their utility in understanding the behaviour of physical systems. c. It aims to introduce the student to the special theory of relativity. d. It focuses on the motion of rigid bodies about any fixed point and any arbitrary axis passing through this point. e. It helps the students understand the elastic properties of materials and the Physics behind the characteristics of liquids. f. It helps the students develop knowledge of the central force and its characteristics, including gravitation. g. It teaches the basics of harmonic motion and its characteristics. It will help the students understand the periodic motions in Nature.
Prerequisite	Students should have elementary knowledge of vectors, algebra, calculus, kinematics, linear and rotational dynamics, energy, elasticity, and oscillations.
Course Objectives	A student will be able to: i. Acquire preliminary knowledge and the mathematics required for the laws of motion, the concept of Galilean invariance, the system of particles, and collisions. ii. Demonstrate the concepts of conservative and non-conservative forces, equilibrium, and fictitious forces that arise in non-inertial reference frames. iii. Understand the analogy between translational and rotational dynamics and the ability to calculate the moment of inertia of various rigid bodies. iv. Describe the general properties of matter and the principles of elasticity, fluid flow, viscosity, and surface tension. v. Analyze the laws of gravitation and central force motion and derive Kepler's law to demonstrate the motion of planets. vi. Explain the phenomenon of simple harmonic motion and the properties of the systems executing it.

Course Outcomes based on RBT and Cognitive Level Mapping At the end of this course, a student will be able to:				
COs	**Statements**	**Cognitive Level Mapping**		
CO1	Define and identify the fundamental laws of motion and associated concepts such as collisions.	R		
CO2	Distinguish between inertial and non-inertial reference frames and interpret the physical consequences arising from them.	U		
CO3	Apply the motion of a particle under central force motion to demonstrate the properties and characteristics of gravitation.	A1		
CO4	Analyse the motion of a rigid body, including translational and rotational motion.	A2		
CO5	Evaluate the differential equation of simple harmonic motion and assess the nature of oscillations.	E		
CO6	Combine and investigate the general properties of matter and various physical constants.	C		
Course Content				
Units	**Content**	**Lecture Hours**	**COs**	**RBT**
Unit I	**Vectors:** Vector Algebra, Scalar and Vector products, Derivatives of a vector with respect to a parameter, Radial and Transverse components of velocity and acceleration, Uniform Circular Motion. **Ordinary Differential Equations:** 1st order homogeneous differential equations, 2nd order homogeneous differential equations with constant coefficients. **Fundamentals of Dynamics:** Laws of motion, Galilean transformation, Conservation laws, System of particles and Centre of Mass, Motion of rockets.	**10**	**1, 2**	**R U A1 A2 E C**

	Collisions: Elastic and Inelastic collisions, Laboratory and Centre of Mass frames.			
Unit II	**Work and Energy:** Conservative and non-conservative forces, Potential Energy. Potential energy curves and equilibrium. Work done by non- conservative forces. Law of Conservation of Energy. **Special Theory of Relativity:** Historical background of Special Theory of Relativity, Postulates. Length contraction. Time dilation. Twin paradox. Relativistic addition of velocities. Relativistic variation of mass, mass-energy equivalence. **Non-Inertial Systems**: Non-inertial frames and fictitious forces. Uniformly rotating frame. Rotating coordinate systems. Centrifugal force. Coriolis force,	**8**	**4, 6**	**R U A1 A2 E C**
Unit III	**Rotational Dynamics:** Angular momentum of a particle and system of particles, Torque, Conservation of angular momentum, Rotation about a fixed axis, Rotational energy, Moment of Inertia, Theorem of perpendicular axis and Theorem of parallel axes. Flywheel, theory of compound pendulum and determination of acceleration due to gravity. **Gravitation and Central Force Motion:** Law of Gravitation. Gravitational potential energy, potential, and field intensity. Motion of a particle under a central force field and Kepler's Laws (statement only). Satellites in circular and geosynchronous orbits.	**12**	**3, 4**	**R U A1 A2 E C**
Unit IV	**Elasticity**: Stress-Strain diagram, Relation between Elastic constants – Young's modulus, Bulk's modulus and modulus of rigidity. Poisson's ratio. Work done in stretching and in twisting a wire, twisting torque on a cylinder or wire.	**9**	**6**	**R U A1 A2 E C**

	Viscosity: Streamline and Turbulent flow, Equation of Continuity, Coefficient of Viscosity. **Surface Tension**: Relation between surface tension and surface energy. Angle of Contact and capillary ascent.			
Unit V	**Oscillations**: Simple Harmonic Motion, its differential equation and solution. Vertical oscillations of the light loaded spring, expression for force constant and determination of acceleration due to gravity. Energy and their time-average values. Damped oscillations (Overview).	**6**	**5**	**R U A1 A2 E C**

Learning Resources:

Text Books

1. Mathur, D.S. (2000). *Mechanics*. S. Chand & Co.
2. Lal B. & Subrahmanyam N. (2002). *Properties of matter*. S. Chand & Co
3. Murugeshan R. (2010). *Elements of properties of matter*. S. Chand & Co.
4. Chatterjee, H. & Sengupta, R. (2010). A *treatise on general properties of matter* (7th rev. ed.). New Central Book Agency (P) Limited

Suggested readings

1. Kittel, K., Knight, W. D., Ruderman, M. A., Helmholz, A. C., & Moyer, B. J. (2011). *Mechanics*. Tata McGraw-Hill
2. Halliday, D., Resnick, R., & Walker, J. (2007) *Fundamentals of physics.* John Wiley & Sons
3. Kleppner, D. & Kolenkow, R. J. (2017) *An introduction to mechanics.* McGraw Hill Education

R: Remembering, U: Understanding, A1: Applying, A2: Analysing, E: Evaluating, C: Creating

Practicals

Course Code	23PHYMIN101
Course Title	Mechanics
Credits	4
Total Hours	75
Hours per Week	5
Course Type	Major
Semester	II
Intended Level	Certificate
Issue(s) Addressed	
Course Offered to	Students not from Physics
Regulation	2023

Course Overview	This course: a. The course helps introduce students to different measuring instruments and their applications and significance. b. It emphasises the need to have hands-on experience with the measurement of physical quantities and understand the theoretical concepts through practical means. c. It aims to help in estimating the physical properties of rigid bodies and the elastic and mechanical properties of different materials using scientific instruments. d. It aims to help in assessing the properties of liquids through simple experiments.
Prerequisite	Students should have elementary knowledge of vectors, algebra, calculus, kinematics, linear and rotational dynamics, energy, elasticity, and oscillations.
Course Objectives	A student will be able to: i. Identify, choose, and calibrate appropriate measuring instruments for a particular experiment. ii. Record experimental data in a systematic manner and compute the results using the right physical or mathematical procedures. iii. Interpret and communicate their results in an appropriate manner using written reports with the necessary data visualizations. iv. Check the credibility of theoretical claims from experiments. v. Nurture their scientific temperament and encourage them to build upon their experience gained from conducting experiments.

Course Outcomes based on Dave's Psychomotor Mapping
At the end of this course, a student will be able to:

COs	Statements	Cognitive Level Mapping
CO1	Replicate the steps required to familiarize themselves with experiments and instruments related to the study of mechanical and elastic properties.	I
CO2	Recreate any previously imitated experiment on the study of mechanical and elastic properties.	M
CO3	Demonstrate skilled use of common measuring instruments such as callipers, gauges, measuring telescopes, etc.	P
CO4	Be proficient in the setup and use of experimental apparatus used for the study of mechanical and elastic properties.	P
CO5	Adapt or modify previously imitated experiments to analyze new mechanical and elastic properties.	A

Course Content

Units	Content	Lecture Hours	COs	Dave's
Unit I	**List of Experiments:** 1. Measurements of length/ diameter using vernier calliper, screw gauge and travelling microscope 2. Determination of *g* and velocity of freely falling body using digital timing technique 3. To study the motion of a spring and calculate (a) it's spring constant, (b) modulus of rigidity of the spring material and (c) value of *g*. 4. To determine the value of *g* using a bar pendulum 5. To determine the surface tension of a liquid by capillary tube method 6. To determine the modulus of rigidity of the material of a wire by dynamical method 7. To determine the modulus of rigidity of the material of a wire by Maxwell's needle 8. To determine the Young's modulus of the material of a wire by optical lever method 9. To determine the moment of inertia of a flywheel ***A minimum of EIGHT (8) experiments is to be performed***	**30**	**1, 2, 3,4,5**	**I M P A**

Learning Resources:
Text Books

1. Chattopadhyay, D., & Rakshit, P. C. (2011). An advanced course in practical physics. New Central Book Agency (P) Limited
2. Raychaudhuri, D. P. (n.d.). Manual of practical physics. Allied Book Agency
3. Dasgupta, C.R. (1985). A handbook of practical physics. Book Syndicate Private Limited
4. Singh, H., & Hemne, P.S. (2022). B.Sc. practical physics. S. Chand & Co.
5. Chandra, B. (2023). *PHY MINOR:Mechanics - Lab guidebook for practicals*. (n.p.)

2. Assessment

The student **must** score a minimum of 40% of the total maximum marks assigned to the entire paper to pass the course, subject to the following restrictions: (i) the student **must** be present for and score a minimum of 40% in the Summative Assessment for theory and practical **each**, (ii) the student must be present for Formative Assessment II (Mid-Semester Examinations), and (iii) the student should have a **minimum** of 75% attendance for the entire course.

Formative Assessment: 50 marks distributed across three different forms of Assessment. Evaluated as per the Assessment & Evaluation Framework Document of Salesian College.
Summative Assessment (Theory):The Summative Assessment will be a written examination of 50 marks of at least 2 hours duration, using the RBT categorization and scheme.

Section	Marks per question	No. of questions to be answered	No. of questions given	Total marks for Section
A	2	5	8	10
B	5	4	6	20
C	10	2	4	20
			Total	**50**

Summative Assessment (Practical):The Summative Assessment will be an examination of 50 marks of at least 3 hours duration. The student will be made to perform one or more experiments chosen at random from the topics given in the syllabus.

Sl. No.	Component	Marks per component
1	Practical Examination	30
2	Viva-voce	10
3	Lab notebook or Lab assignment	10
	Total	**50**

Evaluation Scheme of the entire Course

Component	Marks	Final Weightage	Final Marks
Summative Assessment (Theory)	50		25

Summative Assessment (Practical)	50	50%	25
Formative Assessment I	20		10
Formative Assessment II	50		25
Formative Assessment III	20		10
Attendance	5	100%	5
		Total	100

Prepared by:	Checked and verified by:	Approved by:	External Experts - Board of Studies
(Signature) Dr. Digvijay Kharga (Signature) Mr. Mayukh Mazumdar (Signature) Dr. Prajwal Chettri	(Signature) Dr. Prajwal Chettri Head of the Department	(Signature) Mr. Subhajit Paul Dean of Sciences	(Signature) Dr. Ranjan Sharma Associate Professor Department of Physics Coochbehar Panchanan Barma University (Signature) Dr. Amitabha Bhattacharyya Associate Professor Department of Physics Sikkim University Gangtok, Sikkim (Signature) Mr. Tamanash Das Supervisor (Retd.) Draughtsman Civil Trade ITI Tollygunge Kolkata (Signature) Mr. Aaush Pradhan (Alumnus) 2018 batch

23PHYMDC102 - Quantum Physics for the Curious

3. Course Description

Course Code	23PHYMDC102
Course Title	Quantum Physics for the Curious
Credits	3
Total Hours	45
Hours per Week	3
Course Type	Multi-Disciplinary Course
Semester	II
Intended Level	Certificate
Issue(s) Addressed	
Course Offered to	All Students (except students who have studied Physics)
Regulation	2023
Course Overview	This course: a. Introduce a student to the physics of the very small at a qualitative level without any mathematical or technical prerequisites. b. Introduce the student to the history of the development of quantum theory and its effect on physics c. Give the student a qualitative overview of the Standard Model of particle physics and the experimental apparatus required. d. Briefly acquaint the student with the practical applications of quantum theory. e. Give the student an overview of the modern fields of quantum computing and quantum cryptography.
Prerequisite	Students must have graduated from higher secondary school. Students cannot have studied physics in classes 11 & 12.
Course Objectives	A student will be able to: i. Understanding the history and reasons for the development of quantum theory. ii. Identifying the main ideas and developments in old quantum theory. iii. Identifying the main ideas and developments during the first quantum revolution and its impact on the foundations of physics. iv. Outlining the basic principles of the Standard Model of Particle Physics and its major components, and identifying the major experiments devoted to the field, e.g., CERN. v. Outlining the important practical applications of quantum theory in electronics, chemistry, telecommunications, and imaging. vi. Familiarizing themselves with the ideas of quantum entanglement and its extension into the modern fields of quantum cryptography and quantum computing.
Course Outcomes based on RBT and Cognitive Level Mapping At the end of this course, a student will be able to:	

COs	Statements	Cognitive Level Mapping
CO1	Describe the history and identify the reasons for the development of quantum theory.	R
CO2	Discuss the basic principles of the Standard Model of particle physics and summarize the major experiments devoted to the field.	U
CO3	Qualitatively present the ideas of quantum entanglement and its applications.	A1
CO4	Appraise the main ideas and developments during the first quantum revolution and analyze its impact on the foundations of physics.	A2
CO5	Critique the main ideas and developments in old quantum theory and the first quantum revolution.	E
CO6	Generate the important practical applications of quantum theory in electronics, chemistry, telecommunications, and imaging.	C

Course Content

Units	Content	Lecture Hours	COs	RBT
Unit I	**Old Quantum Theory** *Background information*: The nature of waves; Einstein's special theory of relativity; The spectral lines of hydrogen; the ultraviolet catastrophe *Physics becomes confusing:* The introduction of quanta and the photon; early atomic models; the wave-particle duality of light. *Lights in the darkness:* Matter waves; exclusion principle	**12**	**1,5**	**R U A1 A2 E C**
Unit II	**The First Quantum Revolution** *The birth of quantum mechanics*: Schrodinger's equation; Heisenberg's uncertainty principle; Dirac's antimatter prediction	**11**	**4,5**	**R U A1 A2 E C**

	The death of classical physics: The probabilistic nature of quantum theory; deterministic vs probabilistic schools of thought *A philosophical interlude*: The measurement problem; the Many-World's interpretation and the multiverse			
Unit III	**The Standard Model of Particle Physics** *The most fundamental of all things*: Discoveries of the electron, proton and neutron; overview of the current Standard Model *Discovering the building blocks*: Particle accelerators: CERN, LIGO, IndIGO, and other examples	**8**	**2**	**R U A1 A2 E C**
Unit IV	**Applications of Quantum Mechanics** *Revolutions in technology*: The electronics revolution; lasers, holography and the telecommunications revolution; MRIs; next generation microscopes; superconductivity and exotic states of matter (brief overview)	**7**	**6**	**R U A1 A2 E C**
Unit V	**The Second Quantum Revolution** *Quantum entanglement is weird*: quantum entanglement and its experimental verification *Present day revolutions*: Quantum information; overview of quantum cryptography and quantum computing	**7**	**3**	**R U A1 A2 E C**
Learning Resources:				

Text Books

1. Gribbin, J. (1985). *In search of Schrodinger's cat: Quantum physics and reality*. Black Swan
2. Gamov, G. & Stannard, R. (2001). *The new world of Mr Tompkins* (3rd rev. ed.). Cambridge University Press
3. Rae, A. (2005). *Quantum physics: Beginner's guide*. Pan MacMillian India
4. Baggott, J. (2011). *The quantum story: A history in 40 moments*. Oxford University Press
5. Oerter, R. (2006). *The theory of almost everything: The Standard Model, the unsung triumph of modern physics*. Plume
6. Zeilinger, A. (2023). *Dance of the photons: Einstein, entanglement and quantum teleportation*. Penguin

Suggested readings

1. Simonyi, K. (2012). *A cultural history of physics*. CRC Press
2. Brush, S. (2015). *Making 20th Century science: How theories became knowledge*. Oxford University Press
3. Kumar, M. (2011). *Quantum: Einstein, Bohr and the great debate about the nature of reality*. W.W. Norton & Co.
4. Buchwald, J., & Fox, R. (Eds.). (2017). *The Oxford handbook of the history of physics.* Oxford University Press
5. Zukav, G. (2009). *The dancing Wu Li masters*. HarperOne
6. Baggott, J. (2020). *Quantum reality*. Cambridge University Press
7. Schumm, B. A. (2004). *Deep down things: The breathtaking beauty of particle physics.* The Johns Hopkins University Press
8. Gilder, L. (2009). *The age of entanglement: When quantum physics was reborn*. Knopf

R: Remembering, U: Understanding, A1: Applying, A2: Analysing, E: Evaluating, C: Creating

2. Assessment

The student **must** score a minimum of 40% of the total maximum marks assigned to the entire paper to pass the course, subject to the following restrictions: (i) the student **must** be present for and score a minimum of 40% in the Summative Assessment, (ii) the student must be present for Formative Assessment II (Mid-Semester Examinations), and (iii) the student should have a **minimum** of 75% attendance for the entire course.

Formative Assessment: 50 marks distributed across three different forms of Assessment. Evaluated as per the Assessment & Evaluation Framework Document of Salesian College.

Summative Assessment:The Summative Assessment will be a written examination of 50 marks of at least 2 hours duration, using the RBT categorization and scheme.

Section	Marks per question	No. of questions to be answered	No. of questions given	Total marks for Section
A	2	5	8	10

B	5	4	6	20
C	10	2	4	20
			Total	**50**

Evaluation Scheme of the entire Course

Component	**Marks**	**Final Weightage**	**Final Marks**
Summative Assessment	50	100%	50
Formative Assessment I	20	50%	10
Formative Assessment II	50		25
Formative Assessment III	20		10
Attendance	5	100%	5
		Total	100

Prepared by:	Checked and verified by:	Approved by:	External Experts - Board of Studies
(Signature) Mr. Bikramjit Chandra	(Signature) Dr. Prajwal Chettri Head of the Department	(Signature) Mr. Subhajit Paul Dean of Sciences	(Signature) Dr. Ranjan Sharma Associate Professor Department of Physics Coochbehar Panchanan Barma University (Signature) Dr. Amitabha Bhattacharyya Associate Professor Department of Physics Sikkim University Gangtok, Sikkim (Signature) Mr. Tamanash Das Supervisor (Retd.) Draughtsman Civil Trade ITI Tollygunge Kolkata (Signature) Mr. Aaush Pradhan (Alumnus) 2018 batch

23PHYVAC102 - Quantum Crossroads II

4. Course Description

Course Code	23PHYVAC102
Course Title	Quantum Crossroads II
Credits	1
Total Hours	30
Hours per Week	2
Course Type	Value Added Course
Semester	II
Intended Level	Certificate
Issue(s) Addressed	
Course Offered to	Physics
Regulation	2023
Course Overview	This course: a. Trains a student to plan, rehearse and present technical and mathematical information to an audience of their peers b. Provides students with an avenue to express technical information in an academic or professional environment. c. Trains students to comport themselves vocally and physically while presenting in front of an audience. d. Teaches students the use of digital aids such as slideshow software and projectors for the use of dissemination of information.
Prerequisite	Students must be majoring in Physics. Students must have a reasonable command of English
Course Objectives	A student will be able to: i. Read and understand technical information from a paper, article or other specialized manuals. ii. Analyze and break down the given information and assimilate with pre-existing knowledge. iii. Construct and present technical knowledge to an audience of their peers in a clear and lucid manner. iv. Critically evaluate and argue for or against the thesis of the paper.

Course Outcomes based on RBT and Cognitive Level Mapping
At the end of this course, a student will be able to:

COs	Statements	Cognitive Level Mapping
CO1	Describe the details of the paper being presented	R
CO2	Interpret the paper and relate it to their pre-existing knowledge	U
CO3	Present the knowledge in a clear and lucid manner to an audience of their peers	A1

CO4	Appraise and break down the information being presented.	A2
CO5	Critique and argue for or against the thesis of the paper.	E
CO6	Design and construct a presentation that disseminates knowledge from the paper to an audience.	C

Course Structure

Session Number	Content	Total Hours	COs	RBT
1	Hours 1 & 2: Introduction to the Course	**2**	**-**	**-**
2-8	Hour 1: Presentation by one 2nd year student Hour 2: Summarized report on the presentation	**14**	**1,2,4**	**R U A2 E**
9	Hour 1: Demo presentation by faculty Hour 2: Report on demo presentation	**2**	**1,2,4**	**R U A2 E**
10-15	Hour 1: Presentation by 1st year student Hour 2: Summarized report on the presentation	**12**	**1,3,4, 5,6**	**R A1 A2 E C**

Learning Resources:
None

R: Remembering, U: Understanding, A1: Applying, A2: Analysing, E: Evaluating, C: Creating

2. Assessment

The student **must** score a minimum of 40% of the total maximum marks assigned to the entire paper to pass the course, subject to the following restrictions: (i) the student **must** make a presentation of their own and submit the report of the same assessment, and (ii) the student should have a **minimum** of 75% attendance for the entire course.

Formative Assessment: The Formative Assessment will be of 50 marks and will be based on their individual presentations. This grade will then be converted out of 20.

Summative Assessment:The Summative Assessment will consist of a written report by the student for each presentation that they attend. Each report will be graded out of 10 and finally converted to a fraction of 25 marks.

Sl. No.	Category	Score
1	Organization	15
2	Content Knowledge	25

3	Style	5
4	Delivery	5
	Total	50

Evaluation Scheme of the entire Course

Component	Marks	Final Weightage	Final Marks
Summative Assessment	10 times the number of reports	variable	25
Formative Assessment	50	40%	20
Attendance	5	100%	5
		Total	50

Prepared by:	Checked and verified by:	Approved by:	External Experts - Board of Studies
(Signature) Mr. Bikramjit Chandra	(Signature) Dr. Prajwal Chettri Head of the Department	(Signature) Mr. Subhajit Paul Dean of Sciences	(Signature) Dr. Ranjan Sharma Associate Professor Department of Physics Coochbehar Panchanan Barma University (Signature) Dr. Amitabha Bhattacharyya Associate Professor Department of Physics Sikkim University Gangtok, Sikkim (Signature) Mr. Tamanash Das Supervisor (Retd.) Draughtsman Civil Trade ITI Tollygunge Kolkata (Signature) Mr. Aaush Pradhan (Alumnus) 2018 batch

The curriculum document for the Department of Physics have been carefully examined and approved by the undersigned:

Checked and verified by:	**Approved by:**	**External Experts -** **Board of Studies**
(Signature) Dr. Prajwal Chettri Head of the Department	(Signature) Mr. Subhajit Paul Dean of Sciences	(Signature) Dr. Ranjan Sharma Associate Professor Department of Physics Coochbehar Panchanan Barma University (Signature) Dr. Amitabha Bhattacharyya Associate Professor Department of Physics Sikkim University Gangtok, Sikkim (Signature) Mr. Tamanash Das Supervisor (Retd.) Draughtsman Civil Trade ITI Tollygunge Kolkata (Signature) Mr. Aaush Pradhan (Alumnus) 2018 batch