ST. XAVIER'S COLLEGE – MUMBAI
(Est. 1869)
(An Autonomous College affiliated with the University of Mumbai)

Syllabus for Undergraduate Programme as per National Education Policy (NEP-2020)

Programme: BSc in PHYSICS

The academic year 2023–2024

ST. XAVIER'S COLLEGE-AUTONOMOUS ★ MUMBAI-400 001 ★

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MUMBAI - 400 001.

APPROVED SYLLABUS

Preamble

The foundational principles of the National Education Policy 2020 (NEP 2020) released by MHRD are:

- Multidisciplinary and holistic education (student-centered), encompassing courses from multiple disciplines across the sciences, social sciences, arts, humanities, and commerce for a multidisciplinary world, with emphasis on outcome-based learning.
- 50-50 formulation, where 50% of the credits must be from the core discipline and the rest 50% from other disciplines. Also, 50% of the course must be conceptual and theory based and the rest 50% must be the application of the concepts into practice through student engagement in activities/apprenticeship and internship. Pedagogic methods must be problem-centered/ based and project-based learning and activities.
- Integration of technology into teaching-learning-evaluation resources, blended teaching-learning (face-to-face, online collaborative learning, hands-on and practicum and flipped learning), strengthening research pedagogy of the discipline.
- Integrating skilling and employability with curriculum and teaching-learning across disciplinary, interdisciplinary, and multidisciplinary studies.
- Multiple entry and exit options for students within an academic programme of study with credit transfer and accumulation of credits in the Academic Bank of Credits (ABC).
- Equality is the Goal, and Equity is a process to achieve equality and inclusion to promote students' sense of belonging.

The framework of the choice-based credit system

Major Subject: A single subject course of study pursued by a student as a mandatory requirement of the programme of study. Indian knowledge system (IKS) to be included in the core courses.

Elective Course: An elective course could be a project designed to acquire skills to supplement the major study.

Minor Subject: A second subject of study pursued by a student as an additional requirement of the programme of study.

OE: Open Elective - An elective course chosen generally from an unrelated discipline/subject, to seek multidisciplinary exposure.

AEC: Ability Enhancement Course - Mandatory Courses on content related to Language, and Literature (i) Compulsory – English communication (ii) Elective – any Indian language other than English.

IKS: Indian Knowledge System (Generic) – Mandatory course - an overview of the contribution of India towards multidisciplinary research and development.

VSC: Vocational Skill Course – Courses aimed at imparting practical skills, hands-on training, and soft skills to increase the employability of students. Specific or supporting the major subject is to be chosen from a basket/pool offered by the college.

SEC: Skill Enhancement Course – Courses aimed at imparting practical skills, hands-on training, and soft skills to increase students' employability. It could be chosen from a basket/pool offered by the college or a MOOC on Swayam or NPTEL platforms.

On-Job Training (OJT)/Internship/Field Project (FP)/Community Engagement Programme (CEP) Research Project (RP): Application of knowledge/concepts in solving or analyzing a real-life problem. All these are related to the major subject.

CC: Co-curricular Course – For the holistic development of students through Cultural activities such as performing art, visual art, NCC, NSS, Yoga, etc.

VEC: Value Education Course – Compulsory courses on (i) The Constitution of India and (ii) Environmental Education.

FYUGP Credit Structure with number of courses 2023-24													
Level	Sem	Sub-1/Major	Elective	Sub-2/Minor	OE	VSC	SEC	IKS generic	AEC	VEC	OJT, FP, RP, CEP, CC	Total	Degree/Cum Cr
4.5/100-199 (2023-24) First Year	Sem 1	1	0	1	2	1	1	1	1	1	0	9	44 credits UG certificate
	Sem 2	1	0	1	2	1	1	0	1	1	CC 1	9	
Introductory	Courses	2	0	2	4	2	2	1	2	2	1	18	
Exit option with a UG Certificate in Major &/or Minor with an additional 4 credits NSQF course/internship OR continue with Major & Minor													
5/200-299 (2024-25) Second Year	Sem 3	2	0	1	1	1	0	0	1	0	FP/CEP 1 (Sci) & CC 1	8	88 credits UG Diploma
	Sem 4	2	0	1	1	0	1	0	1	0	FP/CEP 1 (Art/Com) & CC 1	8	
Intermediate	Courses	6	0	4	6	3	3	1	4	2	5	34	
Exit option with a UG Diploma in Major & Minor with an additional 4 credits NSQF course/internship OR continue with Major & Minor													
5.5/300-399 (2025-26) Third Year	Sem 5	3	1	1	0	1	0	0	0	0	FP 1	7	132 credits UG Degree
	Sem 6	3	1	1	0	0	0	0	0	0	OJT 1 Internship	6	
Higher	Courses	12	2	6	6	4	3	1	4	2	7	47	
Exit option with a Three-Year Bachelor Degree with Major and Minor OR continue with Major & Minor (Fourth year by Papers)													
6/400-499 (2026-27) Fourth Year	Sem 7	3	1	RM 1	0	0	0	0	0	0	FP 1	6	176 credits UG Honours
	Sem 8	3	1	0	0	0	0	0	0	0	OJT 1 Internship	5	
Advanced	Courses	18	4	7	6	4	3	1	4	2	9	58	
Exit option with a Three-Year Bachelor Degree with Major and Minor OR continue with Major & Minor (Fourth year by Research)													
6/400-499 (2026-27) Fourth Year	Sem 7	3	1	RM 1	0	0	0	0	0	0	RP 1	6	176 credits UG Honours with Research
	Sem 8	3	1	0	0	0	0	0	0	0	RP 1	5	
Advanced	Courses	18	4	7	6	4	3	1	4	2	9	58	
Four-Year UG Honours with Research Degree with Major and Minor													

FYUGP Credit Structure from 2023-24 (Sci-Arts)										
Level	Sem	Major (Sub-1)	Elective	Minor (Sub-2)	OE	VSC SEC	IKS Generic AEC, VEC	OJT, FP, RP, CEP CC	Cum Cr/Sem	Degree/Cum Cr
4.5 (2023-24)	Sem 1	4	0	4	4	4	6	0	22	44 UG certificate
	Sem 2	4	0	4	4	4	4	2	22	
	Cum Cr	8	0	8	8	8	10	2	44	
A student will decide which of the 2 subjects (Sub-1 or Sub-2) will be major and minor at the end of the second semester (ie the first year) Major subject-specific IKS of 2 credits must be done as 2 units (could be 1 unit + 1 unit) from Sem 3 to Sem 6 Exit option with a UG Certificate in Major with an additional 4 credits core NSQF course/internship OR continue with Major & Minor										
5 (2024-25)	Sem 3	8	0	4	2	2	2	4	22	88 UG Diploma
	Sem 4	8	0	4	2	2	2	4	22	
	Cum Cr	24	0	16	12	12	14	10	88	
Exit option with a UG Diploma in Major & Minor with an additional 4 credits core NSQF course/internship OR continue with Major & Minor										
5.5 (2025-26)	Sem 5	12	4	2	0	2	0	2	22	132 UG Degree
	Sem 6	12	4	2	0	0	0	4	22	
	Cum Cr	48	8	20	12	14	14	16	132	
6 (2026-27)	Sem 7	12	4	4	0	0	0	2	22	176 UG Honours
	Sem 8	12	4	0	0	0	0	6	22	
	Cum Cr	72	16	20	12	14	14	24	176	
Exit option with a Three-Year Bachelor Degree with Major and Minor OR continue with Major & Minor										
6 (2026-27)	Sem 7	10	4	4	0	0	0	4	22	176 UG Honours with Research
	Sem 8	10	4	0	0	0	0	8	22	
	Cum Cr	68	16	20	12	14	14	28	176	
Four-Year UG Honours with Research Degree with Major and Minor										

Programme Outcomes aligned to the Vision and Mission of St. Xavier's College (Autonomous), Mumbai (Bachelor's degree programme)

The students who complete an undergraduate programme will be able to manifest skills and competencies in the following areas:

1. **Disciplinary knowledge and Core competencies/skills:**

   Demonstrate (i) a lucid understanding of the fundamentals of the subject-related curriculum and (ii) basic and global skills in the academic field of study.

2. **Critical and Creative thinking:**

   (i) Critically reflect on acquired knowledge and skills in areas of core competencies (ii) Explore new possibilities and be resourceful by generating relevant and practical ideas

3. **Problem-solving and Analytical reasoning:**

   Demonstrate skills in identifying and investigating a problem. Collect relevant qualitative and quantitative data and analyze the results meaningfully.

4. **Research-related skills:**

   (i) Apply comprehensive research-based knowledge and skills required for identifying issues, interpreting results, and synthesis of valid information. (ii) Communicate results of studies undertaken in an academic field effectively and accurately.

5. **Social Application of research and development:**

   Employ core competencies and skills to develop solutions for the improvement of social and environmental conditions.

6. **Industry-related skills:**

   Employ skills that are relevant to the industry and commit to strong work ethics and professionalism.

7. **Ethical and Moral Integrity:**

   Practice values such as honesty, transparency, and accountability and commit to interpersonal and social ethics.

8. **Empathy and Social Intelligence:**

   Cultivate and demonstrate effective, interpersonal, social, and spiritual intelligence.

9. **Collaboration, Teamwork, and Multidisciplinary competence:**

   Apply knowledge and skills as an individual, team member or leader to manage ventures in monodisciplinary and interdisciplinary settings.

10. **Leadership and Management:**

    Demonstrate effective strategic planning, and efficient organisational and transformational leadership skills to manage a mission embarked upon.

11. **Social Concern:**

    Demonstrate (i) empathy and care for the marginalised and disadvantaged, (ii) respect, compassion, and concern for others.

12. **Social responsibility and inclusion:**

    (i) Strive for social justice, harmony, and solidarity (ii) Value cultural pluralism and diversity.

13. **Environmental Wellbeing**

    Investigate and design strategies to care for and enhance the well-being of the environment.

14. Self-motivation and Lifelong learning:

Develop a passion for ongoing personal and professional growth.

Abbreviations:

- OE: Open Electives
- AEC: Ability Enhancement Course
- VSC: Vocational Skill Course
- SEC: Skill Enhancement Course

List of All Courses offered from Semesters 1- 6 in Physics 18-12-23

Level	Sem	Major (Sub-1) Course titles	Minor (Sub-2) Course titles	Elective Course titles	OE Course title/s	VSC Course title/s	SEC
4.5 100-199	**1**	Mechanics (3+1)			Basic Science of watercolor Art (1+1)	Mechanical measurement techniques (1+1)	Mechanical measurement techniques (1+1)
	2	Waves and thermal physics (3+1)				Mechanical measurement techniques (1+1)	
5 200-299	**3**	Mathematical Methods (3+1)	Mathematical Methods (3+1)			Electrical measurement (1+1)	
		Electricity & Magnetism-1 (3+1)					
	4	Optics (3+1)	Optics (3+1)				
		Electricity & Magnetism-2 (3+1)					+2 SCS
5.5 300-399	**5**	Introduction to Quantum Mechanics (3+1)	Intro to Astronomy (1+1)	Basic electronics (3+1)		Experimental techniques (2)	+2 FP
		Thermodynamics (3+1)					
		Classical Mechanics (3+1)					
	6	Solid State Physics (3+2)	DIP (2)	Nuclear Physics/Advanced Optics (3+1)			+4 OJT
		Atomic and molecular Physics (3+1)					
		Statistical Mechanics (3+2)					

Composition of Board of Studies in Physics 2023-2024

Representation	Name	Affiliation
Chairperson: Head of the Department	Mr. Rajesh Singh	St. Xavier's College, Mumbai
Department faculty members	Dr. Ajay Yadav	St. Xavier's College, Mumbai
	Dr. Rohan Jadhav	St. Xavier's College, Mumbai
	Dr. Leena Joshi	St. Xavier's College, Mumbai
	Dr. Radhekrishna L. Dubey	St. Xavier's College, Mumbai
	Dr Amruta Sadhu	
VC nominee	Dr. Kiran Kolwankar	Ramniranjan Jhunjhunwala College, Mumbai.
Industry Expert	Mr. Umesh Singh.	Frodel enterprises
Subject Experts from other Universities	Dr. Raka Dabhade	Fergusan Collegee, Pune
	Dr Shirish Pathare	HBCSE, TIFR, Mankhurd
	Dr Jyoti Singh	Ajeenkya DY Patil University, Pune
Postgraduate meritorious alumnus	Sriraag Sundaram	sreerag.sundaram@xaviers.edu.in

Four-Year Undergraduate Programme in Physics

Year of Implementation	Semester	Course Code	BOS Date	Academic Council Date
2023-2024	1	All Courses	21-3-2023	21-4-2023
2023-2024	2	All Courses	1-7-2023	29-9-2023

Programme Specific Outcomes (PSOs) for B.Sc. Physics

Sr. No.	On completing B.Sc. Physics, the student will be able to:
PSO 1	Comprehend physics principles and their applications in the problems of everyday life.
PSO 2	Possess industry-specific skills for the existing industrial jobs, and for developing new technologies.
PSO 3	Understand the advanced methods of scientific inquiry and develop skills for extensive research.
PSO 4	Know mathematical methods and computer programming so as to model the advanced theories and provide deductions.
PSO 5	Develop skills for understanding scientific literature and creating scientific communication in written, audio, and video forms.
PSO 6	To apply the physics principles to diverse fields like astronomical, biological sciences, and economics.

Syllabus

First Semester Courses in BSc Physics

2023-2024

Contents:

- Syllabus for Core Course and/or Minor Course and Vocational Skill course (VSC)
  - o USPHY4501CR1- **Mechanics**
  - o USPHY4501VS1- **Mechanical measurement techniques**
- Evaluation and Assessment guidelines

APPROVED SYLLABUS

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F.Y. B.Sc. Physics Course Code:USPHY4501CR1

Mechanics

Credit structure

- Theory credits : 3 (Three hours per week, Total 45 hours)
- Practical credits : 1 (Two hours per week, Total 30 hours)
- Total credits : 4 (Total hours 75)

Prerequisite : Students who have passed class XII with Science.

Course Objectives: To study the fundamentals of Newtonian Mechanics.

Number of lectures: 45

Course Outcomes

On completing the course, the student will be able to:

1. Apply Newton's Laws to any physical situation and deduce its kinematical behavior.
2. Understand the concepts of work power and energy and apply them to industrial and day-to-day life situations
3. Understand and apply the concepts of momentum and its conservation to evaluate the performance of machines
4. Create small dynamical systems to examine the viability of Newton's Laws.
5. Apply the concept of rotation to locomotives and other revolving systems.
6. Analyze the problems involving fluids and their motion in machines..

Theory Syllabus (Total No of hours: 45 Hrs)

Unit 1. Force, Work, and Energy (15 Hours)

1. Newton's Laws Of Motion Force and Interactions, Newton's First Law, Newton's Second Law, Mass and Weight, Newton's Third Law, Free-Body Diagrams, Questions/Exercises/Problems
2. Applying Newton's Laws Using Newton's First Law: Particles in Equilibrium, Using Newton's Second Law: Dynamics of Particles, Frictional Forces, Dynamics of Circular Motion, The Fundamental Forces of Nature, Questions/Exercises/Problems
3. Work And Kinetic Energy Work, Kinetic Energy and the Work-Energy Theorem, Work and Energy with Varying Forces, Power, Questions/Exercises/Problems

Unit 2. Potential energy, Momentum and Rotation (15 Hours)

1. Potential Energy And Energy Conservation, Gravitational Potential Energy, Elastic Potential Energy, Conservative and Non-conservative Forces, Force and Potential Energy, Energy Diagrams, Questions/Exercises/Problems

2. Momentum, Impulse and Collisions, Momentum and Impulse, Conservation of Momentum, Momentum Conservation and Collisions, Elastic Collisions, Center of Mass, Rocket Propulsion, Questions/Exercises/Problems
3. Rotation of Rigid Bodies, Angular Velocity and Acceleration, Rotation with Constant Angular Acceleration, Relating Linear and Angular Kinematics, Energy in Rotational Motion, Parallel-Axis Theorem, Moment-of-Inertia Calculations, Questions/Exercises/Problems

Unit 3. Rotation, Fluids and Gravitation (15 Hours)

1. Dynamics Of Rotational Motion, Torque, Torque and Angular Acceleration for a Rigid Body Rigid-Body Rotation About a Moving Axis Work and Power in Rotational Motion, Angular Momentum, Conservation of Angular Momentum, Gyroscopes and Precession, Questions/Exercises/Problems
2. Fluid Mechanics Density, Pressure in a Fluid, Buoyancy, Fluid Flow, Bernoulli's Equation, Viscosity and Turbulence, Questions/Exercises/Problems
3. Gravitation Newton's Law of Gravitation, Weight, Gravitational Potential Energy, The Motion of Satellites, Kepler's Laws and the Motion of Planets, Spherical Mass Distributions, Apparent Weight and the Earth's Rotation, Black Holes, Questions/Exercises/Problems

References

1. University Physics, Sears & Zemansky, Young and Freedman, Pearson 14, 15th Edition
2. Fundamentals of Physics, Halliday and Resnick, 10th Edition, Wiley

Practicals Syllabus

Total No of hours : 30 Hrs

1. Minimum four Experiments in the complete semester from the following list
    a. Skill experiments
    b. Error Analysis and significant figures
    c. Density of Material
    d. Acceleration due to Gravity
    e. Video Analysis: Coefficient of Restitution
    f. Friction: Dynamic and Kinetic friction
    g. Flywheel

2. Project
    a. In a complete semester, a student must perform one project related to the course.

References

1. Advanced Practical Physics – Worsnop & Flint
2. Advanced course in Practical Physics D. Chattopadhyay, P.C. Rakshit & B. Saha
3. B. Sc. Practical Physics –C. L. Arora

Evaluation plan

Theory evaluations:
Total marks per course - 100.

1. Formative Assessment 'for' Learning (continuous internal assessment - CIA to improve learning).
   CIA 1: Written test -25 marks Scaled to 40.
2. Summative Assessment 'of' Learning (focus on outcomes, quantitative data for outcomes of instruction).
   End Semester Examination – 60 marks

Practical evaluations:

1. CIA: Experimental Project work with report: 25 marks each
2. Exam on regular experiments: 20 marks
3. Journal: 5 marks

Template for the Core course End Semester examination in Semester I

Units	Knowledge	Understanding	Application & Analyses	Total Marks Per Unit
1	8	8	4	20
2	8	8	4	20
3	8	8	4	20
-Total - Per Objective	24	24	12	60
% Weightage	40%	40%	30%	100%

F.Y. B.Sc. Physics Course Code: USPHY4501VS1

Mechanical measurement techniques

Credit structure

- Theory credits : 1 (One hour per week, Total 15 hours)
- Practical credits : 1 (Two hours per week, Total 30 hours)
- Total credits : 2 (Total hours 45)

Prerequisite : Students who have passed class XII with Science.

Course Objectives : To study the Basic measurement techniques with error analysis

Number of lectures: 45
Course Outcomes (COs):
On completing the course, the student will be able to:

1. Understand the concept of significant figures and different types of errors.
2. Apple the basic measurement techniques to various situations.
3. Evaluate the associated error involved with any measurements

Theory syllabus (15 hours)
Unit 1

1. **Significant figures & Basic Error analysis:** Significant figures**,** Types of error, error propagation, estimation of error using statistical method.
2. **Mechanical Measurement tools 1**: Length measurement using Vernier caliper (analog and digital), Thickness measurement using Micrometer screw gauge,) Use of traveling microscope, Use of Sextant to measure the height of buildings, Spherometer.
3. **Mechanical Measurement tools 2:** The tape measure.The framing square, The level, The short rule, The try square, Mortise Gauge, 9” Protractor Square, Plumb Bob

Unit 2

1. **Mechanical Measurement tools 3:** Weighing machine measurement (Spring type and beam balance, Density meter, Densitometer, Hygrometer (for measurement of humidity), Rain gauge meter
2. **Thermal measurements**: Temperature measurement using thermometer and thermocouple (digital), Pressure measurement using Barometer,
3. **Mechanical measurements using light**: Principles of optical lever, Spectrometer, Interferometers

References

1. A Handbook of Physics Measurements, Volume 1, Heywood S. Broun, Forgotten Book publisher,2012, ISBN-13 : 978-1440083938
2. An introduction to error analysis, John R. Taylor, second edition, University science books
3. Measurement, Instrumentation and Experiment Design in Physics and Engineering, M. Sayer & A. Mansingh, Prentice Hall India Learning Private Limited, ISBN-13 : 978-8120312692

Practical syllabus

Total No of hours : 30 Hrs, Total credits : 1

List of experiments

1. Measuring the density of a rectangular sheet of aluminium/copper sample
2. Measurement of the diameter of a thin wire using micrometer screw gauge
3. Determination of wire gauge element using traveling microscope
4. Radius of curvature using optical lever
5. Spectroscopy: Spectrometer to measure the spectrum of a light source.
6. Interference: Newton's rings experiment measure the wavelength of light.

Minimum experiment requirements in a semester are 4

Evaluation Plan
Total marks for the course - 50.

Theory evaluations
Formative Assessment 'for' Learning (continuous internal assessment - CIA to improve learning).
Theory CIA- 20 marks
Template for the theory exam question paper

UNITS	KNOWLEDGE	UNDERSTANDING	APPLICATION and ANALYSES	TOTAL MARKS- Per unit
1	4	3	3	10
2	4	3	3	10
-TOTAL - Per objective	8	6	6	20
% WEIGHTAGE	40%	30%	30%	100%

Practical evaluations
Evaluation of Practicals as End Semester Practical Examination – 30 marks.

F.Y. B.Sc. Physics Course Code: USPHY4501SE1

Mechanical measurement techniques

Credit structure

- Theory credits : 1 (One hour per week, Total 15 hours)
- Practical credits : 1 (Two hours per week, Total 30 hours)
- Total credits : 2 (Total hours 45)

Prerequisite : Students who have passed class XII with Science.

Course Objectives : To study the Basic measurement techniques with error analysis

Number of lectures: 45

Course Outcomes (COs):

On completing the course, the student will be able to:

1. Understand the concept of significant figures and different types of errors.
2. Apple the basic measurement techniques to various situations.
3. Evaluate the associated error involved with any measurements

Theory Syllabus (15 hours)

Unit 1

1. **Significant figures & Basic Error analysis:** Significant figures**,** Types of error, error propagation, estimation of error using statistical method.
2. **Mechanical Measurement tools 1**: Length measurement using Vernier calliper (analog and digital), Thickness measurement using Micrometer screw gauge,) Use of travelling microscope, Use of Sextant to measure the height of buildings, Spherometer.
3. **Mechanical Measurement tools 2:** The tape measure.The framing square, The level, The short rule, The try square, Mortise Gauge, 9" Protractor Square, Plumb Bob

Unit 2

1. **Mechanical Measurement tools 3:** Weighing machine measurement (Spring type and beam balance, Density meter, Densitometer, Hygrometer (for measurement of humidity), Rain gauge meter
2. **Thermal measurements**: Temperature measurement using thermometer and thermocouple (digital), Pressure measurement using Barometer,
3. **Mechanical measurements using light**: Principles of optical lever, Spectrometer, Interferometers

References

1. A Handbook of Physics Measurements, Volume 1, Heywood S. Broun, Forgotten Book publisher,2012, ISBN-13 : 978-1440083938
2. An introduction to error analysis, John R. Taylor, second edition, University science books
3. Measurement, Instrumentation and Experiment Design in Physics and Engineering, M. Sayer & A. Mansingh, Prentice Hall India Learning Private Limited, ISBN-13 : 978-8120312692

Practical syllabus

Total No of hours : 30 Hrs, Total credits : 1

List of experiments

1. Measuring the density of a rectangular sheet of aluminum/copper sample
2. Measurement of the diameter of a thin wire using micrometer screw gauge
3. Determination of wire gauge element using traveling microscope
4. Radius of curvature using optical lever
5. Spectroscopy: Spectrometer to measure the spectrum of a light source.
6. Interference: Newton's rings experiment measure the wavelength of light.

Minimum experiment requirements in a semester are 4

Evaluation Plan
Total marks for the course - 50.

Theory evaluations
Formative Assessment 'for' Learning (continuous internal assessment - CIA to improve learning).
Theory CIA- 20 marks
Template for the theory exam question paper

UNITS	KNOWLEDGE	UNDERSTANDING	APPLICATION and ANALYSES	TOTAL MARKS- Per unit
1	4	3	3	10
2	4	3	3	10
-TOTAL - Per objective	8	6	6	20
% WEIGHTAGE	40%	30%	30%	100%

Practical evaluations
Evaluation of Practicals as End Semester Practical Examination – 30 marks.

Syllabus

First Semester Courses in Physics

2023-2024

Contents:

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F.Y.B.Sc. Course Code: USPHY4501OE1

Basic Science of watercolour art

Credit structure

- Total credits : 2 (Total hours 30)
- Two hours each week allotted for theory and practical instructions.

Prerequisite : Students who have passed class XII.

Course Objectives: To study the Science and art of watercolour paintings at an introductory level.

Number of lectures: 30

Course Outcomes (COs):

On completing the course, the student will be able to:

1. Understand different watercolour papers, their strengths and weaknesses
2. Apply different types of washes and understand their uses.
3. Understand tonal range and create artworks demonstrating the tonal range.
4. Learn colour theory, primary, secondary and tertiary colours and their use
5. Identify the vanishing points and learn a single point / two point perspective.
6. Create artwork using aerial and one / two point perspectives.

Theory Syllabus (Total No of hours : 15 Hrs)

Unit 1

1. Introduction to Materials and Equipment
    a. Paper : Cotton papers, cellulose paper, Hot pressed, Cold pressed, Reflectance, Absorptivity, drying time etc, Stretching, Hand made papers vs Machine made papers, Sizing, Acid free Paper
    b. Watercolour Paints : Principal Ingredients, Student grade vs Professional grade, Tubes vs Cakes, Making a pallet
    c. Brushes: Natural hair brushes, artificial hair brushes, Rigger, round and flat brushes.
    d. Other equipment needed.
2. Flat wash and graded wash. Understanding Tonal range (Values or Grey levels).
3. Basic brush strokes : Basic brush strokes.
4. Simple perspective drawing, Eye level and vanishing lines, One point perspective, Two point perspective, Aerial perspective, use of graphite and its properties.

Unit 2

1. Creative Composition: Basic compositional ideas. Important Steps before creating a composition.
2. Separating Tone and Colour, Colour charts.

3. Exploring Colours, Primary colours of light, Primary colours of print/pigments, Colour Wheel, Warm vs Cool colours, Transparent vs Opaque colours, Lightfastness in colours
4. Colour theories, Mixing colours, Mixing in palette, Mixing on paper.
5. Building Up a Paintwork : Tonal layers, Colour Temperature layers, Connected shapes
6. A brief history of watercolour painting.

References

1. The Essence of Watercolour_ The Secrets and Techniques of Watercolour Painting Revealed, Hazel Soan
2. David Bellamy's complete guide to watercolour painting, David Bellamy, Collins
3. Watercolour Landscapes Step-By-Step, Geoff Kersey, Search Press

Practical Syllabus

Total No of hours : 15 Hrs

List of experiments

1. Flat washes and graded washes, Separation of tones, A three tone painting
2. Different brush strokes and creation of simple textures, Wash techniques like wet-in-wet, splattering
3. Simple One point perspective drawing in mono tonal work
4. Colours, colour wheel and applications. Mixing colours, in palette , on paper. Primary secondary and tertiary colours.
5. Simple two point perspective, aerial perspective.
6. Simplifying a scene and creating a monotone study.
7. Creating a small (roughly A4 size) artwork from a photograph.
8. Field work, Visits, Plein air sessions.

Minimum requirements of experiments in a semester

1. Seven experiments for completion of course.
2. One project related to the course.

Evaluation Plan

Theory evaluations

Formative Assessment ‘for’ Learning (continuous internal assessment - CIA to improve learning).
Theory CIA- 20 marks
Template for the theory exam question paper

UNITS	KNOWLEDGE	UNDERSTANDING	APPLICATION and ANALYSES	TOTAL MARKS- Per unit
1	4	3	3	10
2	4	3	3	10
-TOTAL - Per objective	8	6	6	20
% WEIGHTAGE	40%	30%	30%	100%

Practical evaluations

1. End Semester Practical exam (30 Marks)
    a. Skill exam: 5 Marks
    b. Comprehensive artwork exam: 15 marks
    c. Journal: 10 Marks

Syllabus

Second Semester Courses in BSc Physics

2023-2024

Contents:

- Syllabus for Core Course and/or Minor Course and Vocational Skill course (VSC)
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APPROVED SYLLABUS

ST. XAVIER'S COLLEGE-AUTONOMOUS ★ MUMBAI-400 001 ★

PRINCIPAL
ST. XAVIER'S COLLEGE
AUTONOMOUS
MUMBAI - 400 001.

F.Y. B.Sc. Physics Course Code: USPHY4502CR1

Waves and Thermodynamics

Credit structure

- Theory credits : 3 (Three hours per week, Total 45 hours)
- Practical credits : 1 (Two hours per week, Total 30 hours)
- Total credits : 4 (Total hours 75)

Prerequisite : Students who have passed class XII with Science.

Course Objectives: To study the fundamentals of Newtonian Mechanics.

Number of lectures: 45

Course Outcomes

On completing the course, the student will be able to:

1. Analyze the conditions for static Equilibrium and solve Rigid-Body Equilibrium Problems.
2. Understand the Simple Harmonic oscillation and damped oscillations in various mechanical systems and their applications.
3. Understand the thermal properties of material and heat transfer mechanism.
4. Evaluate the basic concepts of thermodynamics such as state variables, state of a system, work done, and internal energy.
5. Create small systems using the laws of thermodynamics to demonstrate day-to-day phenomena.
6. Analyze the performance of heat engines, steam power plants, and refrigerators and their components using the first law of thermodynamics.

Theory Syllabus (Total No of hours : 45 Hrs)

Unit 1. Oscillations and waves **(15 Hours)**

1. **Equilibrium and elasticity**

   Conditions for Equilibrium, Center of Gravity, Solving Rigid-Body Equilibrium Problems, Stress, Strain, and Elastic Moduli Elasticity and Plasticity, Questions/Exercises/Problems

2. **Periodic motion**

   Describing Oscillation, Simple Harmonic Motion, Energy in Simple Harmonic Motion Applications of Simple Harmonic Motion, the Simple Pendulum, the Physical Pendulum, Damped Oscillations, Forced Oscillations and Resonance, Questions/Exercises/Problems

3. **Mechanical waves**

   Types of Mechanical Waves, Periodic Waves, Mathematical Description of a Wave, Speed of a Transverse Wave, Energy in Wave Motion, Wave Interference, Boundary Conditions, and Superposition, Standing Waves on a String, Normal Modes of a String, Questions/Exercises/Problems

Unit 2. Sound and Thermodynamics **(15 Hours)**

1. **Sound and hearing:** Sound Waves, Speed of Sound Waves, Sound Intensity, Standing Sound Waves and Normal Modes, Resonance and Sound Interference of Waves, Beats, The Doppler Effect, Shock Waves, Questions/Exercises/Problems
2. **Temperature and heat:** Temperature and Thermal Equilibrium, Thermometers and Temperature Scales, Gas Thermometers and the Kelvin Scale, Thermal Expansion, Quantity of Heat, Calorimetry and Phase Changes, Mechanisms of Heat Transfer, Questions/Exercises/Problems
3. **Thermal properties of matter:** Equations of State, Molecular Properties of Matter, Kinetic-Molecular Model of an Ideal Gas, Heat Capacities, Molecular Speeds, Phases of Matter, Summary, Questions/Exercises/Problems

Unit 3. Laws of thermodynamics **(15 Hours)**

1. **The first law of thermodynamics:** Thermodynamic Systems, Work Done During Volume Changes, Paths Between Thermodynamic States, Internal Energy and the First Law of Thermodynamics, Kinds of Thermodynamic Processes, Internal Energy of an Ideal Gas, Heat Capacities of an Ideal Gas, Adiabatic Processes for an Ideal Gas Questions/Exercises/Problems
2. **The second law of thermodynamics:** Directions of Thermodynamic Processes, Heat Engines, Internal-Combustion Engines, Refrigerators, The Second Law of Thermodynamics, The Carnot Cycle, Entropy, Microscopic Interpretation of Entropy, Questions/Exercises/Problems

References

1. University Physics, Sears & Zemansky, Young and Freedman, Pearson 14, 15th Edition
2. Fundamentals of Physics, Halliday and Resnick, 10th Edition, Wiley

Practicals Syllabus

Total No of hours : 30 Hrs

1. Minimum four Experiments in the complete semester from the following list
    a. Acceleration due to Gravity
    b. Compound Pendulum
    c. Young's Modulus
    d. Specific Heat of material
    e. Viscosity of liquid
    f. Coefficient of thermal expansion of solids.
    g. Velocity of waves/sound in a medium.
1. Project
    a. In a complete semester, a student must perform one project related to the course.

References

1. Advanced Practical Physics – Worsnop & Flint

2. Advanced course in Practical Physics D. Chattopadhyay, P.C. Rakshit & B. Saha
3. B. Sc. Practical Physics –C. L. Arora

Evaluation plan

Theory evaluations :
Total marks per course - 100.

1. Formative Assessment 'for' Learning (continuous internal assessment - CIA to improve learning).
   CIA 1: Written test -25 marks Scaled to 40.
2. Summative Assessment 'of' Learning (focus on outcomes, quantitative data for outcomes of instruction).
   End Semester Examination – 60 marks

Practical evaluations :

1. CIA : Experimental Project work with report : 25 marks each
2. Exam on regular experiments: 20 marks
3. Journal: 5 marks

Template for the Core course End Semester examination in Semester 2

UNITS	KNOWLEDGE	UNDERSTANDING	APPLICATION and ANALYSES	TOTAL MARKS- Per unit
1	8	8	4	20
2	8	8	4	20
3	8	8	4	20
-TOTAL - Per objective	24	24	12	60
% WEIGHTAGE	40%	40%	30%	100%

F.Y. B.Sc. Physics Course Code: USPHY4501VS1

Mechanical measurement techniques

Credit structure

- Theory credits : 1 (One hour per week, Total 15 hours)
- Practical credits : 1 (Two hours per week, Total 30 hours)
- Total credits : 2 (Total hours 45)

Prerequisite : Students who have passed class XII with Science.

Course Objectives : To study the Basic measurement techniques with error analysis

Number of lectures: 45

Course Outcomes (COs):

On completing the course, the student will be able to:

1. Understand the concept of significant figures and different types of errors.
2. Apple the basic measurement techniques to various situations.
3. Evaluate the associated error involved with any measurements

Theory Syllabus (15 hours)

Unit 1

1. **Significant figures & Basic Error analysis:** Significant figures**,** Types of error, error propagation, estimation of error using statistical method.
2. **Mechanical Measurement tools 1**: Length measurement using Vernier caliper (analog and digital), Thickness measurement using Micrometer screw gauge,) Use of traveling microscope, Use of Sextant to measure the height of buildings, Spherometer.
3. **Mechanical Measurement tools 2:** The tape measure.The framing square, The level, The short rule, The try square, Mortise Gauge, 9” Protractor Square, Plumb Bob

Unit 2

1. **Mechanical Measurement tools 3:** Weighing machine measurement (Spring type and beam balance, Density meter, Densitometer, Hygrometer (for measurement of humidity), Rain gauge meter
2. **Thermal measurements**: Temperature measurement using thermometer and thermocouple (digital), Pressure measurement using Barometer,
3. **Mechanical measurements using light**: Principles of optical lever, Spectrometer, Interferometers

References

1. A Handbook of Physics Measurements, Volume 1, Heywood S. Broun, Forgotten Book publisher,2012, ISBN-13 : 978-1440083938
2. An introduction to error analysis, John R. Taylor, second edition, University science books
3. Measurement, Instrumentation and Experiment Design in Physics and Engineering, M. Sayer & A. Mansingh, Prentice Hall India Learning Private Limited, ISBN-13 : 978-8120312692

Practical syllabus

Total No of hours : 30 Hrs, Total credits : 1

List of experiments

1. Measuring density of a rectangular sheet of aluminium/copper sample
2. Measurement of diameter of a thin wire using micrometer screw gauge
3. Determination of wire gauge element using traveling microscope
4. Radius of curvature using optical lever
5. Spectroscopy: Spectrometer to measure the spectrum of a light source.
6. Interference: Newton's rings experiment measure the wavelength of light.

Minimum requirements of experiments in a semester is 4

Evaluation Plan
Total marks for the course - 50.

Theory evaluations
Formative Assessment 'for' Learning (continuous internal assessment - CIA to improve learning).
Theory CIA- 20 marks
Template for the theory exam question paper

UNITS	KNOWLEDGE	UNDERSTANDING	APPLICATION and ANALYSES	TOTAL MARKS- Per unit
1	4	3	3	10
2	4	3	3	10
-TOTAL - Per objective	8	6	6	20
% WEIGHTAGE	40%	30%	30%	100%

Practical evaluations
Evaluation of Practicals as End Semester Practical Examination – 30 marks.